

Figure 1

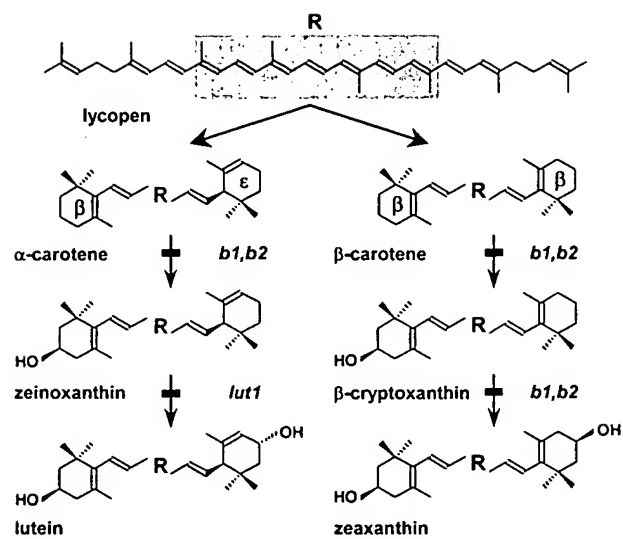


Figure 2

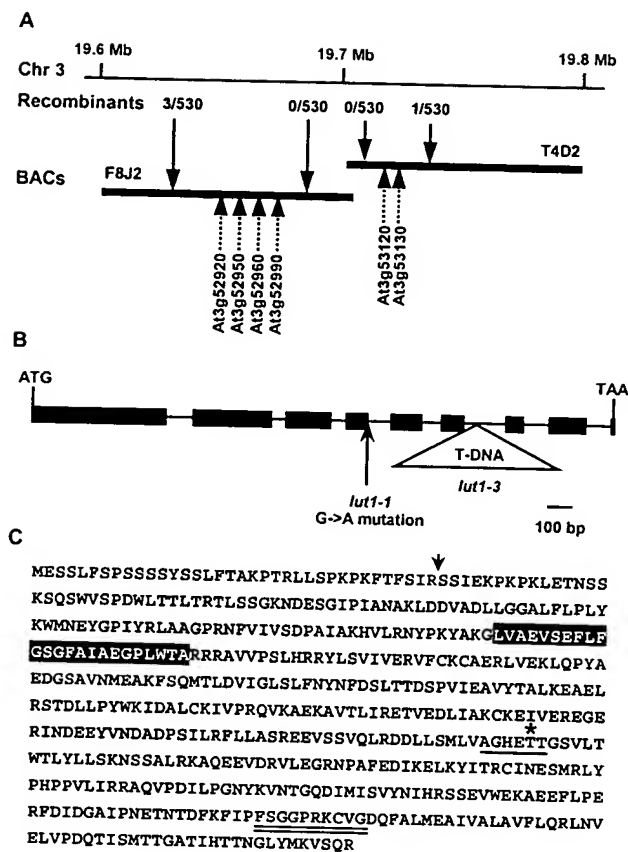


Figure 3

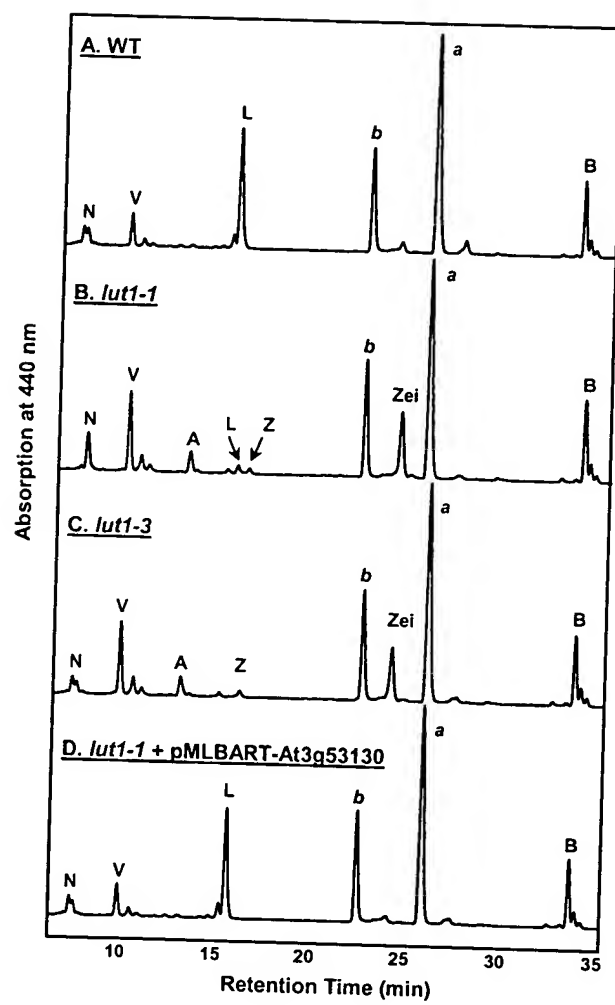


Figure 4

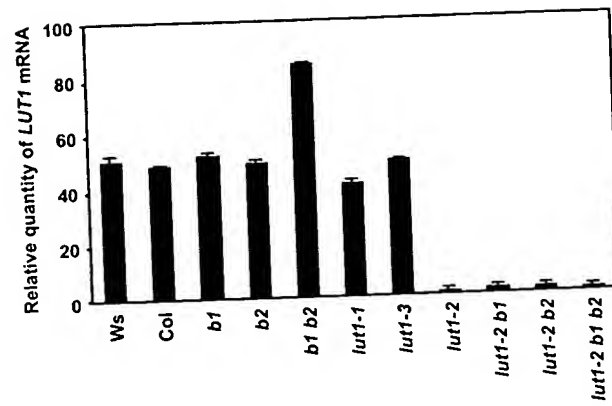


Figure 5

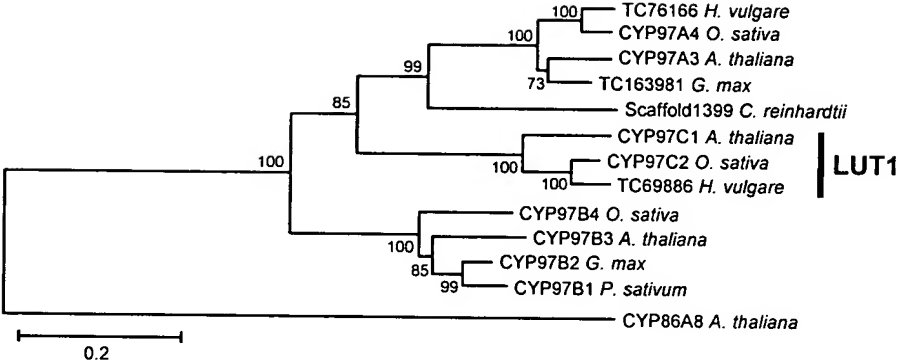


Figure 6

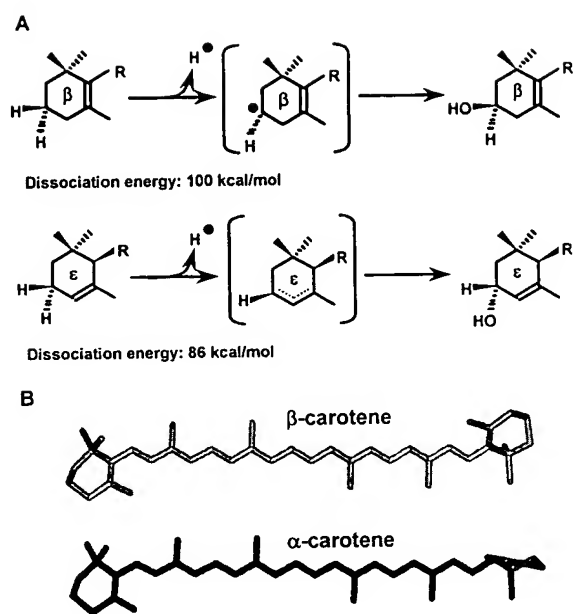


Figure 7

**CYP97A3(Arabidopsis) single knockout mutant (SALK\_116660)**

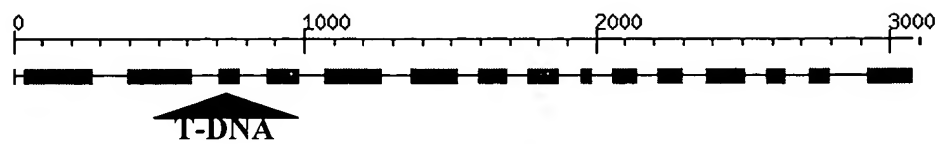
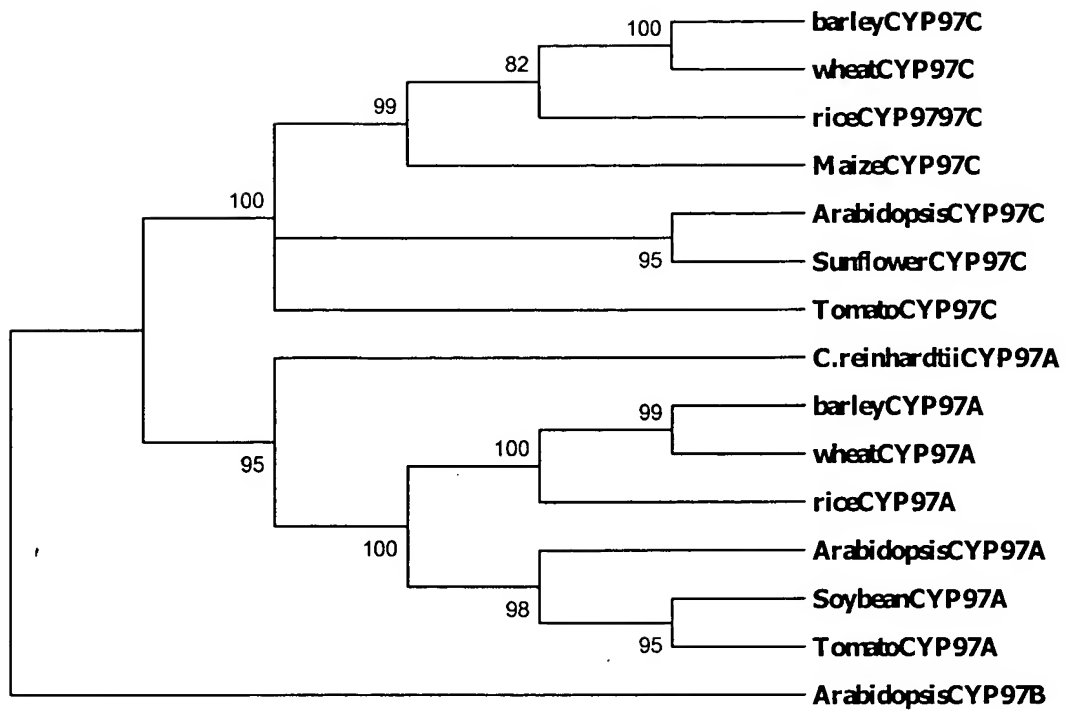


Figure 8



Phylogenetic tree

(Neighbor-joining tree with p-distance, Pairwise deletion method was used. Arabidopsis CYP97B is an outgroup.)

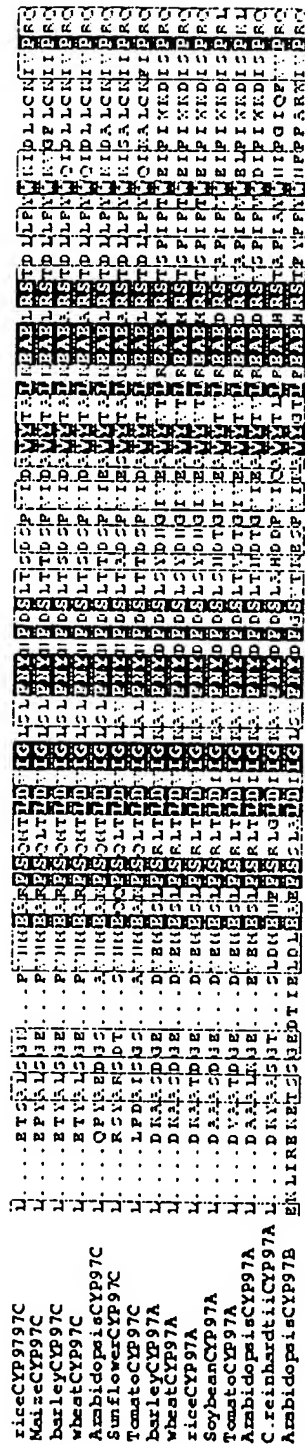


Figure 9

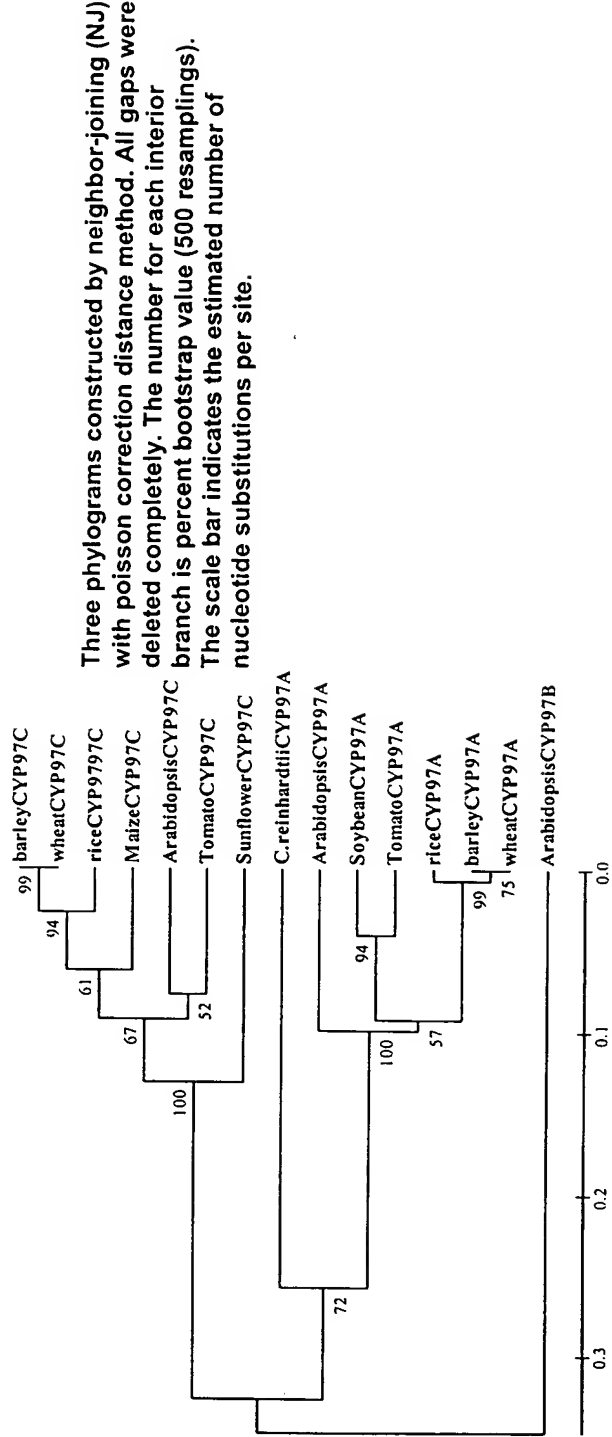
## Amino acid similarity

	CYP97A	CYP97C
Arabidopsis	100%	100%
Rice	405/544 (74%),	385/488 (78%),
Barley	374/481 (77%),	395/524 (75%),
G. max (Soybean)	343/410 (83%)	not included
Wheat	243/328 (74%)	254/350 (72%),
tomato	441/546 (80%),	226/279 (81%),
sunflower	not included	167/202 (82%),
maize	not included	145/177 (81%),
Chlamydomonas	223/365 (61%),	not included

Figure 10

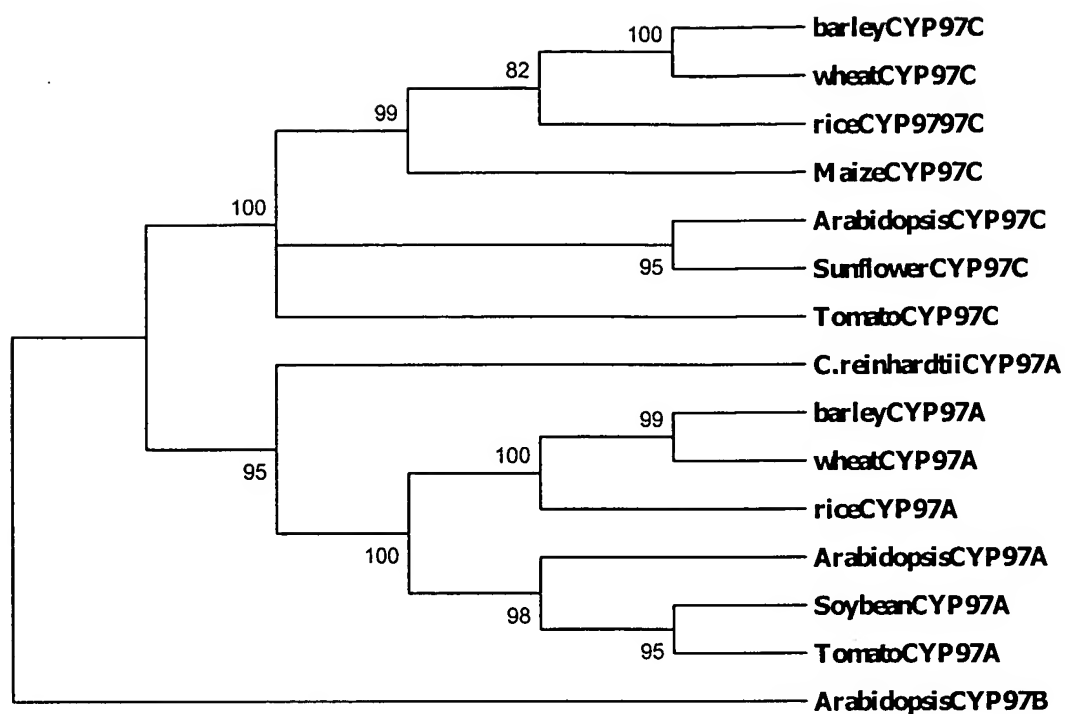


These amino acids were used for constructing phylogenetic trees



Three phylograms constructed by neighbor-joining (NJ) with poisson correction distance method. All gaps were deleted completely. The number for each interior branch is percent bootstrap value (500 resamplings). The scale bar indicates the estimated number of nucleotide substitutions per site.

Figure 11



Phylogenetic tree

(Neighbor-joining tree with p-distance, Pairwise deletion method was used. Arabidopsis CYP97B is an outgroup.)

Figure 12

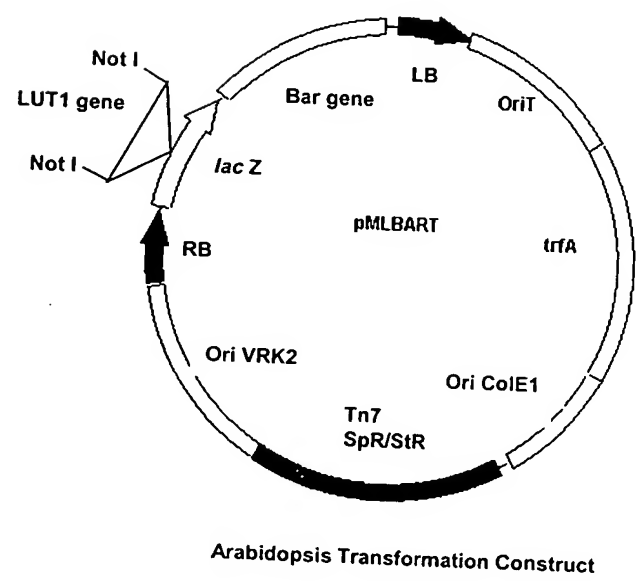
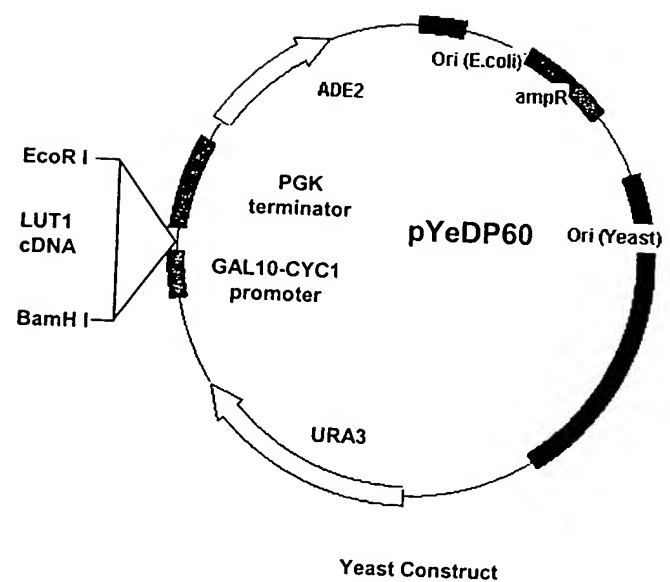


Figure 13

**Table 1.  $\beta$ -Xanthophyll production and  $\beta$ -ring hydroxylation in leaf tissue of wild type and carotenoid hydroxylase mutants<sup>\*</sup>**

Genotype	$\beta$ -Xanthophylls <sup>†</sup>	Hydroxylated $\beta$ -rings <sup>‡</sup>
Ws	54.0 $\pm$ 2.7 <sup>§</sup>	48.5 $\pm$ 1.0 <sup>a</sup>
Col	60.7 $\pm$ 7.6 <sup>a</sup>	48.7 $\pm$ 0.9 <sup>a</sup>
<i>b1 b2</i>	20.5 $\pm$ 4.8 <sup>b</sup>	40.2 $\pm$ 1.4 <sup>b</sup>
<i>lut1-2 b1 b2</i>	26.5 $\pm$ 3.4 <sup>b</sup>	33.6 $\pm$ 2.4 <sup>c</sup>
<i>lut1-3 b1 b2</i>	28.3 $\pm$ 4.6 <sup>b</sup>	31.1 $\pm$ 1.2 <sup>c</sup>

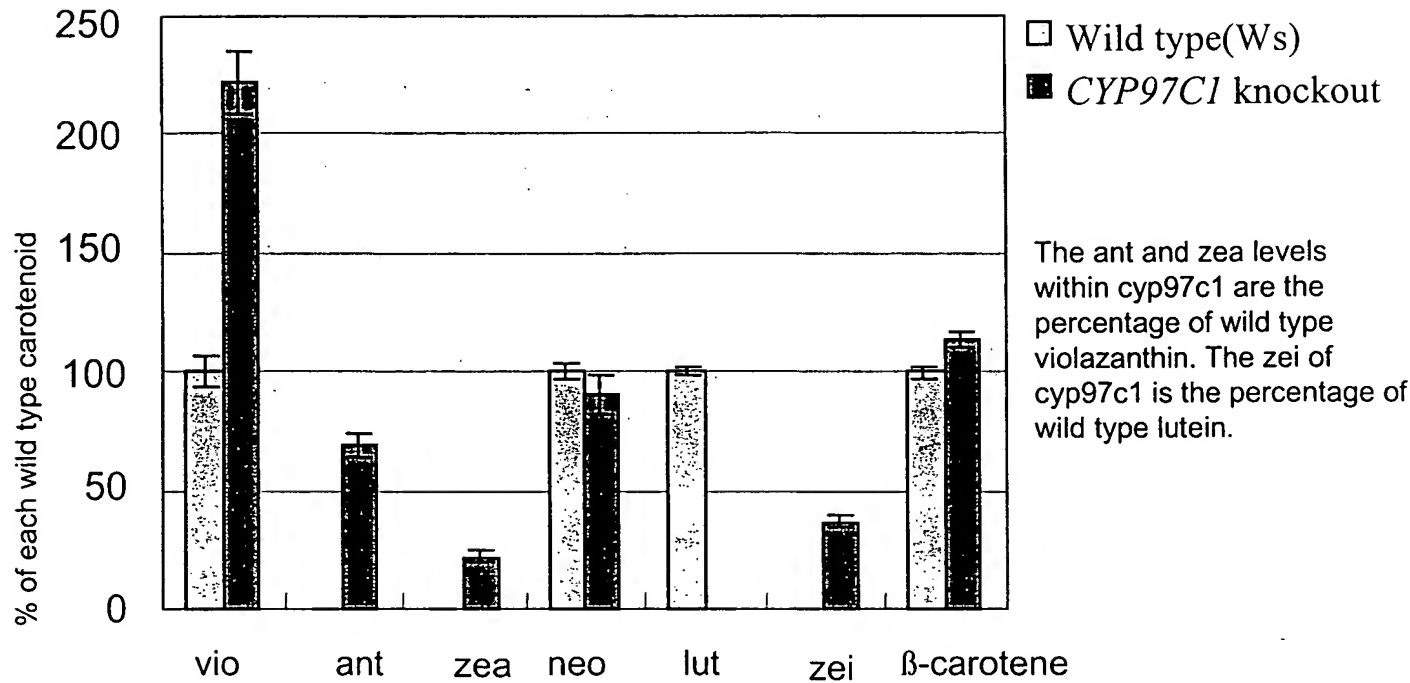
<sup>\*</sup> Total carotenoids were extracted from five-week-old plants and quantified by HPLC as previously described (Tian et al., 2003).

<sup>†</sup>  $\beta$ -xanthophylls are the sum of zeaxanthin, antheraxanthin, violaxanthin, and neoxanthin as mmol pigment/ mol chlorophyll *a* + *b*.

<sup>‡</sup> Data are given as percentage of total ring hydroxylation.

<sup>§</sup> All values are means  $\pm$  SD (*n* = 6). Values marked with the same letters are not significantly different from each other within a column (Student's *t* test, *P* > 0.05).

Figure 14

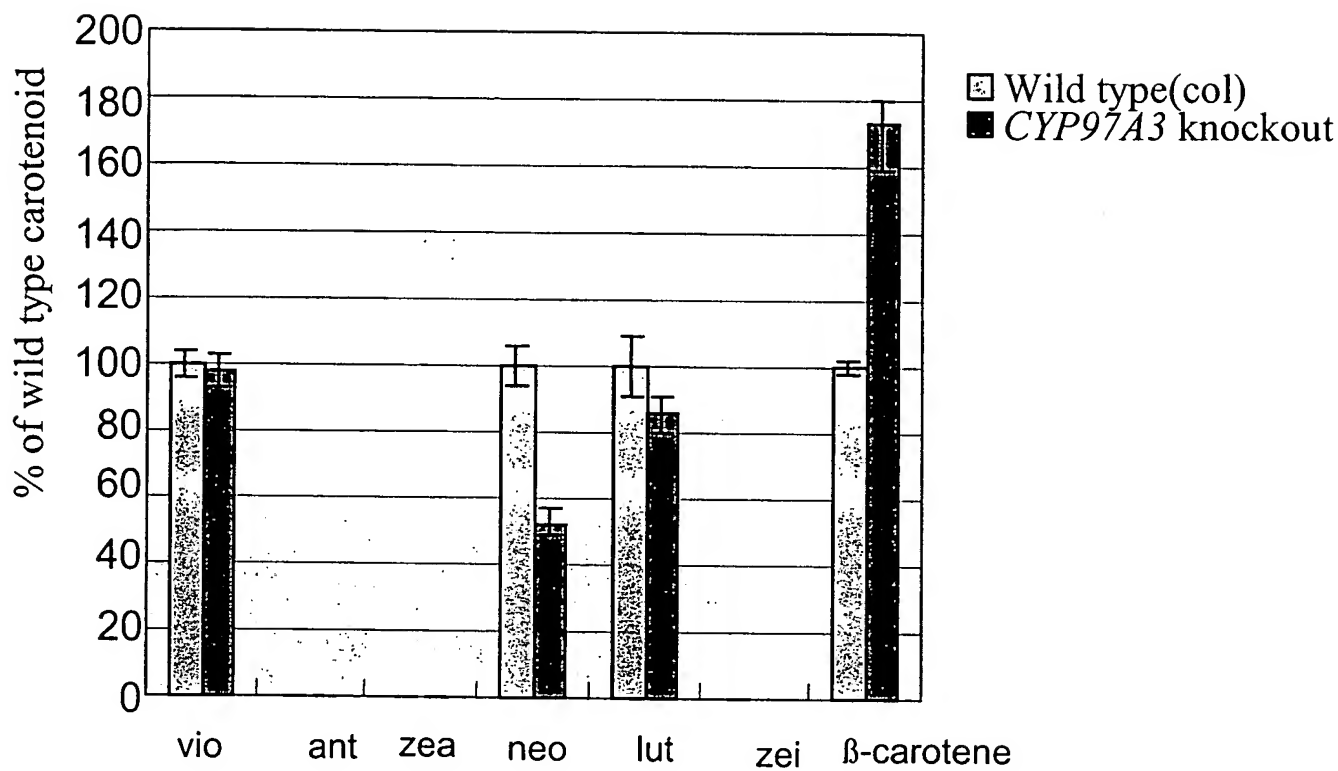


Neoxanthin level is not significantly different between wild type and *CYP97C1* knockout ( $p > 0.05$ )

Student t-test (two-tails)

	vio	ant	zea	neo	lut	zei	β- carotene
Ws/ <i>cyp97c1</i>	0.007098	0.001631	0.00604	0.111459	9.22469E- 05	0.00153	0.04776516

Figure 15

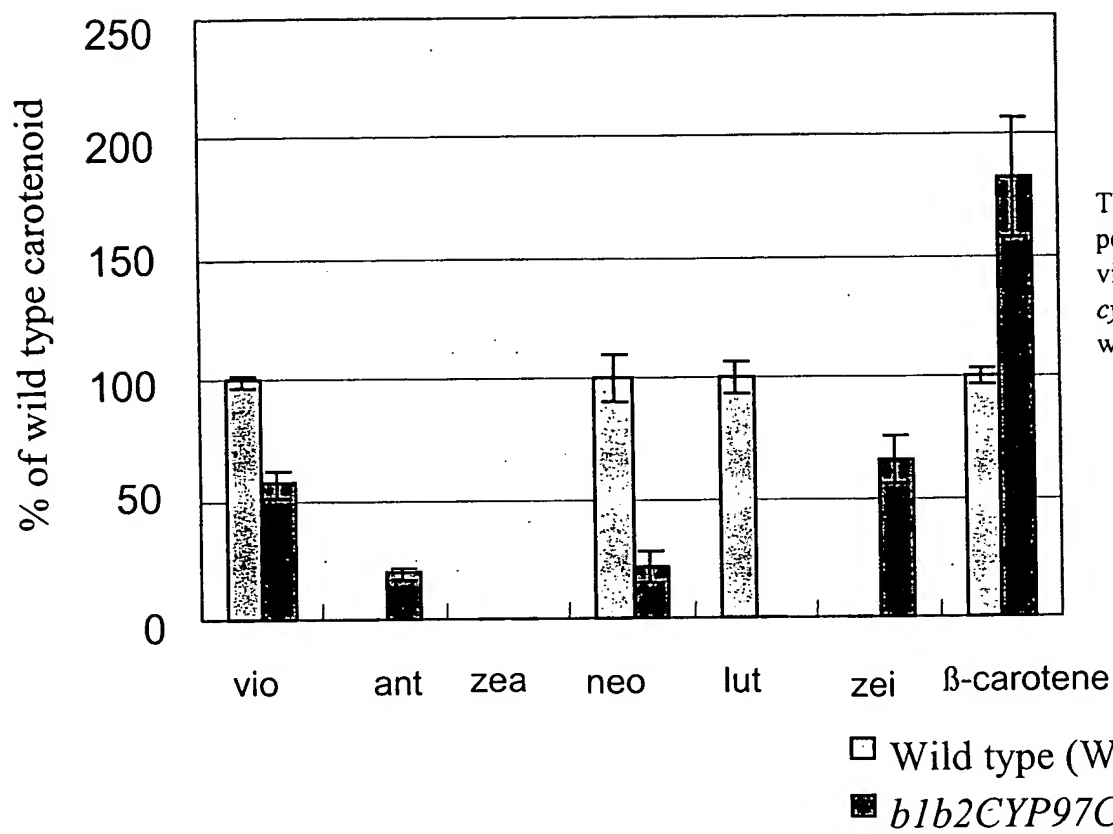


Student t-test (two-tails)

	vio	ant	zea	neo	lut	zei	β-carotene
Col/cyp97a3	0.63368	n/a	n/a	0.01116	0.03972875	n/a	0.009973

violaxanthin level is not significantly different between wild type and *CYP97C1* knockout ( $p>0.05$ )

Figure 16



Student t-test (two-tails)

	vio	ant	zea	neo	lut	zei	β-carotene
ws/b1b2cyp97c1	0.0076	0.0041	n/a	0.0141	0.001563	0.0068	0.032631



Figure 17

	vio/(chia+b)	ant/(chia+b)	zea/(chia+b)	neo/(chia+b)	lut/(chia+b)	zei/(a+b)	$\beta$ -car/(chia+b)
wild type(Ws)	100	0	0	100	100	0	100
STDEV, wild type(Ws)	6.1	0	0	3.17	1.66	0	2.43
<i>CYP97C1</i> knockout	221.8388	69.77	21.94	89.97	0	36.82	113.17
STDEV, <i>CYP97C1</i> knockout	12.72	4.89	2.97	8.14	0	2.49	2.96
wild type(col)	100	0	0	100	100	0	100
STDEV, wild type (col)	3.78	0	0	5.83	8.67	0	2.34
<i>CYP97A3</i> knockout	98.12	0	0	52	86.2	0	173.49
STDEV, <i>CYP97A3</i> knockout (col)	5.05	0	0	3.03	6.13	0	14.42
wild type(Ws)	100	0	0	100	100	0	100
STDEV, wild type(Ws)	2.36	0	0	9.83	6.86	0	3.18
<i>b1b2CYP97C1</i> triple knockout	57.15	19.36	0	21.17	0	65.62	182.97
STDEV, <i>b1b2CYP97C1</i> triple knocko	5.39	2.14	0	7.16	0	9.43	24.7

**Fig. 18**

SEQ ID NO: 1: CYP97C *Arabidopsis thaliana*:  
LQPYAEDGSAVNMEAKFSQMTLDVIGLSLFNYNFDSLTTDSPVIEAVYTALKEAELRSTDLLPYWKIDALC  
KIVPRQ

SEQ ID NO: 2: CYP97A *Arabidopsis thaliana*:  
LDAAALKGEEVEMESLFSRLTLDIIGKAVFNFDLSLTNDTGVIIEAVYTVLREAEDRSVSPVWDIPIWK  
DISPRQ

SEQ ID NO: 3: CYP97B *Arabidopsis thaliana*:  
EKLIREKETSSGEDTIELDLAEFSSLALDIIGLSVFNYDFGSVTKESPVIAVYGTLFEAHRSTFYFPY  
WNFP PARWIVPRQ

Figure 19a

SEQ ID NO: 4: LUT1 *Arabidopsis thaliana* (CYP97C1):

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SEQ ID NO: 5: LUT1 *Arabidopsis thaliana* (CYP97C1):

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Figure 19b

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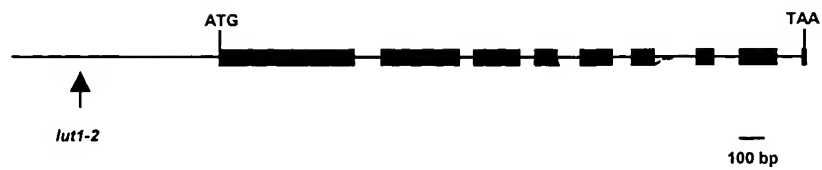
**Figure 20**

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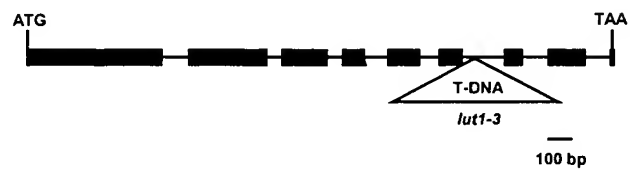
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atcgcataatcgaagctgatgttgcatgtgaggggtttcaggtatcaagtggtgcagttacgggatgatct  
tctctcaatgctcgtagcgggtcatgaaaccactggatctgtcctcacttggacactttatctcctaagta  
agatcaccttaatgtatcttctactttgctatgctagagaatttacttggatgggagcttctctgttctcat  
ttacctcttcaattctctatgttcatagaactcatctgcattaaggaaagcacaagaagaagtagacaga  
gtgttagaaggaagaaacccggctttcgaggatataaaggagttgaagtacatcactcgttgtataaacga  
gtcaatgcgtctctatcctcatcctcctgtaagcaatcaagctcatctctctaattattcatgaactaat  
tttctgattgatttgtttcctggtaggtcttgataagaagagctcaagttcctgacattcttctcgggaac  
tataaggtcaataaccggacaagacattatgatttcagtcctataacatccatcgttcttccgagggtacagtt  
ctcttcttctctcgtccatagtataacataggggagcctaactcttctcttcaatgatcttgtgtggtt  
cggatatctaaccggagtgagacattcctagtattacattcatgcccacatttcttatgtgttgtgtgttg  
ttattccaaagggtatgggaaaaagctgaggaatttctgcctgaacgattcgacatagatggcgcaatccct  
aacgaaacaaacactgatttcaagtaaacctcagtagaacacatcttttgacacaaactactgaatcaagat  
tagtgggttttgattaggggaattttaaagatgattttctttttaccagattcatccattcagtgagggg  
cctagaaaatgtgtaggcgatcagtttgcattgatggaggcaattgtggcactcgcggtgttcttcagcg  
gttaaagcttgagctggttctgatcagaccattagcatgaccacaggagcaaccatacacaccaccaatg  
tatgccaatgttctcacactcgagagattaatgagagtgctgttttgtttagaatgattccaatttctct  
aatgctgatattttcaatttcagggttgatatgaaggtgagccaaaggtaa

**Figure 21**

SEQ ID NO: 8: LUT1-2 mutant *Arabidopsis thaliana* (*lut1-2*):



SEQ ID NO: 9: mutant *Arabidopsis thaliana* LUT1-3 (*lut1-3*)



**Figure 22**

SEQ ID NO: 10: conserved transmembrane domain:  
**LVAEVSEFLFGSGFAIAEGPLWTA**

SEQ ID NO: 11: conserved an N-terminal transit peptide for  
chloroplast-targeting: **MESSLFPSSSSSYSSLFTAKPTRLLSPKPKFTFSIR**

SEQ ID NO: 12: conserved consensus motif of cytochrome P450  
monooxygenase molecular oxygen binding pocket: (A/G)GX(D/E)T(T/S)

SEQ ID NO: 13: conserved sequence of cytochrome P450 monooxygenase  
molecular oxygen binding pocket in LUT1 *Arabidopsis thaliana*: AGHETT

SEQ ID NO: 14: conserved consensus cysteine motif in p450  
monooxygenase enzymes: **FXXGXXXCXG**

SEQ ID NO: 15: conserved cysteine sequence in LUT1 *Arabidopsis*  
*thaliana*: **FSGGPRKCVG**

Fig. 23

SEQ ID NO: 16: rice CYP97C2 *Oryza sativa*:

MAAAAAAACPVPFLCPPPPPLVSPRLRRGHVRLRLRPPRSSGGGGGGGAGGDEPPITTSWVSPDWLTALSR  
SVATRLGGGDDSGIPVASAKLDDVRDLLGGALFLPLFKWFREEGPVYRLAAGPRDLVVVSDPAVARHVLRGY  
GSRYEKGLVAEVSEFLFGSGFAIAEGALWTVRRRSVVPVSLHKRFLSMVDRVFCCKAERLVEKLETSALSGK  
PVNMEARFSQMTLDVIGLSLFNYNFDSLTSDSPVIDAVYTALKEAELRSTDLLPYWKIDLLCKIVPRQIKAE  
KAVNIIRNTVEDLITKCKKIVDAENEQIEGEEYVNEADPSILRFLASREEVTSVQLRDDLLSMLVAGHETT  
GSVLTWTIYLLSKDPAALRRAQAEVDRVLQGRLPYEDLKELKYLRCINESMRLYPHPPVLIRRAIVDDVL  
PGNYKIKAGQDIMISVYNIHRSPEVWDRADDFIPERFDLEGPVNETNTEYRFIPFSGGPRKCVGDQFALLE  
AIVALAVVLQKMDIELVPDQKINMTTGATIHNTTNGLYMNVSLRKVDREPDFALSGSR

SEQ ID NO: 17: barley CYP97C *Hordeum vulgare*:

MPAAAFASALASPPPPWAPRPSPRHASRLRPPRSSGGGDKPTTSWVSPDWLTSLRSVLGRGNDDSGIPV  
ASAKLDDVQDLLGGALFLPLFKWFREEGPVYRLAAGPRDFVIVSDPAVAKHVLRGYGYTRYEKGLVAEVSEFL  
FGSGFAIAEGALWTVRRRAVVPVSLHKRFLSMVDKVFCKAERLVEKLETYALSGEPVNMEARFSQMTLDVI  
GLSLFNYNFDSLTSDSPVIDAVYTALKEAEARSTDLLPYWQIDLLCKIVPRQIKAEKAVNTIRNTVEELIK  
CKAIVDAENEQIEGEEYVNEADPSILRFLASREEVSSLQRDDLLSMLVAGHETTGSVLTWTIYLLSKDPV  
ALRRAQDEVDRLQGRLPYEDVKELKYLRCINESMRLYPHPPVLIRRALVDDVLPNGYKVKTGQDIMISV  
YNIHRSPEVWDRADDFIPERFDLEGPVNETNTEYRFIPFSGGPRKCVGDQFALLEAIVALAIVIQKMDVQL  
VADQKISMTTGATIHNTTNGLYMNVXLRKVEQADLALSPSG

SEQ ID NO: 18: wheat CYP97C *Triticum aestivum*:

MPAAAFASAFASPPPPWAPRPPPRHASRLRPPRSSNNSSGGGGDKPTTSWVSPDWLTSLRSVLGRGNDD  
SGIPVASAKLDDVQDLLGGALFLPLFKWFREEGPVYRLAAGPRDFVIVSDPAVAKHVLRGYGYTRYEKGLVAE  
VSEFLFGSGFAIAEGALWTVRRRAVVPVSLHKRFLSMVDKVFCKAERLVEKLETYALSGEPVNMEARFSQM  
TLDVIGLSLFNYNFDSLTSDSPVIDAVYTALKEAEARSTDLLPYWQIDLLCKIVPRQIKAEKAVNTIRNTVE  
ELITKCKAIVDAENEQIEGEEYVNEADPSILRFLASREEVSSLQRDDLLSMLVAGHETTGSVPDYRLQAQ  
GS

SEQ ID NO: 19: tomato CYP97C *Lycopersicon esculentum*:

CRCAERMVEKLLPDAISGSAVNMEAKFSQTLTDVIGLALFNYNFDSLTTDSPVIDAVYTALKEAELRSTDLL  
PYWQIKALCKFIIPRQIKAENAVSLIRQTVEELIAKCREIVETEGERINEDEYVNDRDPSILRFLASREEVS  
SLQLRDDLLSMLVAGHETTGSVLTWTAYLLSKDPSSLEKAHEEVDRVLGGRSPTYEDMKNLKFLTRCITESL  
RLYPHPPVLIRRAQVADVLPNGYKVNVDQDIMISVYNIHSSKVWDRAEEFDPERFDLERSRP

SEQ ID NO: 20: maize CYP97C *Zea mays*:

LEPYALSGEPVNMEARFSQTLTDVIGLSLFNYNFDSLTTDSPVIDAVYTALKEAELRSTDLLPYWKVGFLLCK  
IIPRQIKAENAVTIIRNTVEELIMKCKEIVEAENEQIEGEEYVNEGDPSILRFLASRDEVSSVQLRDDLLS  
MLVAGHETTGSVLTWTIYLLSKDPTALRRAQDE

SEQ ID NO: 21: sunflower CYP97C *Helianthus annuus*:

GPRNFVIVSDPEIAKHVLRNYGSIYAKGLVAEVSEFLFGSGFAIAEGSLWTARRRAVVPVSLHKKYLSVIVDR  
VFCKCSERLVEKLRSYARSDTSVNMEQQFSQTLTDVIGLAVFNYNFDSLTTADSPVIESVYTALKEAEARSTD  
LLPYWKISALCKIIPRQIKAEQAVTVIRETVEELIKCKEIVEKEGEKIDDEDYVNDATYIFIC



**Figure 24a**

SEQ ID NO: 22: rice CYP97C *Oryza sativa*:

atggccgcccgcgcccgcgcccgcgcccgcgtcccgtgcgtaccattcctgtgcccgcctcctccgccattgggtctcg  
ccgctctccgcccgtggccacgtccgcctccgcctgcccgcgccaaggagcagcggcggtggaggcggaggc  
ggagcggggggagacgagccgcccacaccacctcgtgggtgagccccgactgggtcacggcgctctccgc  
tcggtggcaaccgcctcggcgggggagcagactcggggatccccgtcgccctccgccaagctcgacgacgtg  
cgggacctcctcggcggcgcgctcttctcctcctctcttcaagtgggtccgcgaggaaggccccgtctaccgc  
ctcgcggcggggccgcgggatctcgtcgtcgtcagcgatccccgcggttgccaggcacgtgctgctgggtac  
ggttcgaggtagcagaaggggctcgtcgcgaggtttccgagttcctcttcggctccgggttcgccatcgcc  
gagggcgctctctggacggtgagacgtcgatcagttgtaccatctctacacaaacgatttctctcggtgatg  
gttgacagagtttttgtaaatgtgctgagagattagtggaagcgttgagacatctgctttaagtggcaaa  
cctgtaaatatggaagcaaggttctctcaaatgacttttagatgtgattggttgtccttgaattacaat  
tttgattccctcacatcagatagccctgtttattgatgctgtttacactgcactcaaggaagcagaacttcgt  
tctacagatcttttaccatactggaagattgatttgcgtgcaagattgttccttagacaaataaaagcagaa  
aaggcagttaacatcatcaggaataccggttgaggacctaataccaaatgcaagaagattgtagatgctgag  
aatgaacaaattgagggtaggaatatgtaaagaggcagaccctagcatcctgcgattcctacttgctagc  
cgtgaagaggtaaccagtggtcagttacgtgatgatctattgtcaatgttagttgctgggtcatgaaacaaca  
ggctctgtactgacgtggactatttatctctcagtaaggatccagcagcgtgaggagagctcaagcagag  
gttgaccgtgttctacaaggtagactccccagatatgaagatctaaaagagctgaagtacttgatgcgctgt  
ataaatgagctctatgcggctttatccacaccacctgtgttgatacggcgagccatagttgatgatgtgctt  
ccccgaaactataagatcaaagctgggtcaagatattatgatttcagtgtacaatatacacagggtcacctgag  
gtttgggacagagctgatgattttatcctgagagatttgatttagagggacctgttccaaatgagacaaac  
actgaatacagatttatcccattcagtgagggtcctcggaatgtgttgagatcagtttgctctcttgaa  
gcaattgtggcacttgctgttgtgttgagaagatggacattgagcttgtgccagatcaaaaaattaacatg  
actactggggccacaattcatacaaccaatggcctgtatatgaatgtaagtctgcgtaaagttgacagggaa  
cctgattttgcactcagtggggtccagatga

SEQ ID NO: 23: barley CYP97C *Hordeum vulgare*:

atgcccgcgcgcccattcgctccgcgctcgcgtctcctcctcctccatgggccccacgaccgtccccctcgg  
cacgtagcctccgcctgcccccgccaaggagcagcggcgggcggaggggacaagcccaccacgtcgtgggtc  
agccccgactgggtcacgtcgtgtccgcctcgggtgctcggccggggaaacgacgactcggggatccccgtc  
gcctccgccaagctcgacgacgtgcaggacctcctcggggcgcgctcttctccgctcttcaagtgggtc  
cgcgaggaaagggcccgctaccgcctcgcgcggggcgcgacttcgtcatcgtcagcgaccccgccgtg  
gccaagcacgtcctccgcgggtacggcacgcggtacgagaaggggctcgtcgccgaggtctccgagttcctc  
tttggctctgggttcgccatcgccgaggagcgctctggacggtgagacgtagagcagttgtaccatctcta  
cacaaaagatttctctcagtaatggttgataaagtgttttgtaaatgtgctgagagattgggtggaaaagctc  
gagacatatgctttgagcgggtgaacctgttaatatggaagcgagattttctcaaatgacactagatgtgatt  
ggtttgtctttgttcaactacaactttgattccctcacatcagatagtcctgttattgatgctgtttacacc  
gcactgaaagaagcagaggctcgttctacagatcttttaccatactggcagattgatttgctgtgcaagatt  
gttccttagacagatcaaagcagaaaaggcagttaacacaataaggaatactgttgaagagctaattataaaa  
tgcaaggcaatcgtagatgctgaaaatgaacagattgaggggtgaagaatatgtaaatgaggcagatcctagc  
atcctgcgttttttacttgctagccgtgaagagggtcagcagtttgacgttacgtgatgatctattgtcaatg  
ttagttgctgggtcacgaaacaacaggctctgtactgacatggactatttatcttctcagtaaggatccagta  
gcactaaggagagcccagatgaggtagatcgtgttctacaaggtagactccaagatatgaagatgtaaaa  
gagctgaagtacttgatgcgctgtatcaatgagtcctatgcggctatacccacatcctcctgtgctgatacgg  
cgtgcactagttgatgatgtgcttctggaaactacaagggttaagactggtaagatattatgatttctgtg  
tacaatattcacagatcacctgaggtatgggacagagcagatgaattcattccagagagatttgatttgag  
gggtcccattccaatgagtcacacaccgatttcagggtttatcccttccagtggagggtcctcgaaaatgtgtt  
ggagatcagtttgctcttttagaagcaatttggtgcacttgcaattgtcatcaaaaagatggacgttcagctt  
gtggcagatcaaaaaatcagcatgaccactggggccaccatccatacaaccaatggactgcatgaatgta  
agnctgcgtaaagttgagcaagaagctgacttagcactgagtcctcaggttag

**Figure 24b**

SEQ ID NO: 24: wheat CYP97C *Triticum aestivum*:

atgccccgcccggcattcgccctccgcgttcgcgtctcctcctcctccgtgggccccacgaccgcctcctcgc  
cacgccagcctccgcctgccccgccaaggagcagcagcaacaacagcggcggcggcggaggggacaagccc  
accacctcgtgggtcagccccgactggctgacgtcgcgtgtctcgcgtcgggtgctcggccgggggaacgacgac  
tcggggatacccgctcgccctccgccaagctcgacgacgtgcaggacctcctcgggggcgcgctcttcctgccg  
ctcttcaagtgggtccgcgaggaagggcccgcttaccgcctcgcgcggggcgcgcgacttcgtcatcgtc  
agcgacccccgcgtagccaagcacgtcctccgcgggtacggcacgcggtacgagaaggggctcgtcgcgcgag  
gtctccgagttcctctttggctctgggttcgccatcgccgagggagcgctctggacgggtgagacgtagagca  
gttgtagcatctctacacaaaagatttctctcagtaattggctgataaagtgttctgtaaattgtgctgagaga  
ttggtggaaaagctcgagacttatgctttgagtggtgaacctgttaatatggaagcgaggttttctcaaattg  
acattagatgtgattgggtttatccttggttcaactacaactttgattccctcacatcagatagtcctgttatt  
gatgctgtttacactgcactcaaagaagctgaggctcggttctacagatcttttaccatactggcagatcgat  
ttgctgtgcaagattgttcctagacagataaaaagcggaaaaagcagttaacacaataaaggaaataccggtgaa  
gaggaattacaaaaatgcaaggcaatcgtagatgctgaaaatgaacagattgaggggtgaagaatatgtaaat  
gaggcagatcctagcatcctgcggtttttacttgctagccgtgaagaggtcagcagtttgcagttacgtgat  
gatctattgtcaatgttagttgctggtcatgaacaacagggttctgtaccagactatcgattacaagcccaa  
ggttcc

SEQ ID NO: 25: tomato CYP97C *Lycopersicon esculentum*:

tgcagatgtgctgagagaatgggtggagaaacttttacctgatgcaatttctggctctgcagtgaatatggag  
gcaaagttttctcaactaacacttgatgttattggccttgactcttcaattacaattttgattcccttact  
actgacagtcagttattgatgcagtttactgcactaaaagaagcagaactccgttcaactgatttggtg  
ccatattggcagatcaaagctttatgtaagttcatccacgacaaaataaaggctgagaatgcagtgctatta  
atcagacaaaacagttgaagaacttattgcaagtgacagagattgtagaaaactgaggggtgagaggattaat  
gaagatgagtacgtgaatgatagagatccaagcatccttcgatttttgcttgctagccgtgaggaggtttca  
agtttacaacttcgagatgatcttctgtcaatgctagtgtgctgggcatgaaaccacaggttcagttttgact  
tggacggcatacctgctgagtaaggacccttcctctttggaaaaagcacatgaggaagtagacagagtttg  
ggaggacgctctccgacttatgaagatatgaagaatctcaagttcttaacacggtgcataactgagtcactc  
agactctatccacatccactgtcctgataagacgagctcaagtagctgatgtcctccccgggaattacaaa  
gtcaatgttggtcaggatataatgatttcggtatataacattcatcattcttcaaaagttagggatagagct  
gaagaatttgatcctgaaagattcgacttggaagggtcccgtcccaa

SEQ ID NO: 26: maize CYP97C *Zea mays*:

cttgagccatatgctttgagtggggaacctgtcaatatggaagcgaggtttttctcagttgacattggatgtg  
attggtttatcattgttcaactacaattttgattccctcacacagatagtcctgtcattgatgctgtttat  
actgcactcaaagaagcagagcttcgttctacagatcttttgccatactggaagggttggtttcttggtgcaag  
ataatcccaagacagataaaaagcagagaatgcggttacgattataaggaacactggtgaagagctgattatg  
aagtgtaaagaaatagtggagctgaaaatgaacagattgaggggtgaggaatatgtaaacgaaggggaccc  
agcattctacgcttctacttgctagccgagatgaggtgaagcagtgtaacaattacgtgatgatctcttgca  
atgttagttgctggtcatgaaacaacaggctctgtactgacgtggacaatctatcttctcagtaaggatccg  
actgcactgaggagagctcaagatgaa

SEQ ID NO: 27: sunflower CYP97C *Helianthus annuus*:

gggccaagaaactttgtgattgtgagtgacccggagattgctaagcatgtgttgaggaattatgggagtatt  
tatgctaaaggccttggtgctgaggtctctgagttcttggttttgccattgctgaaggctct  
ctttggactgcaaggcgcagggtgtgagttccatcacttcacaagaagtacttatcagtaatagttgatcgt  
gtattttgcaaatgctccgagaggcttgctgaaaaagctaagatcatacgcacgcagtgacacgtctgttaac  
atggagcaacagttttcgcagttaacccttgatgttatcggcttagccgtatttaactacaattttgactca  
cttacggccgatagctgtaattgaatctgtttataccgcactaaaagaagctgaagcccggttcaactgat  
cttttgccatattggaagataagtgcggttatgtaagattataccaagacaaaataaaaagccgagcaagcagtt  
actgtaattagagaaactgtcgaagaacttattataaaaatgcaaggaaatcggttgaaggaggtgaaaaa  
atagacgatgaagattacgtaaatgatgcaacctatatcttcatctgc

**Figure 25**

SEQ ID NO: 28: forward At3g53130 primer  
5'-CTTCCTCTTCTTACTCTTCTCTCTTCACT-3'

SEQ ID NO: 29: reverse At3g53130 primer  
5'-AAGAACGATGGATGTTATAGACTGAAATC-3'

SEQ ID NO: 30: *LUT1* TaqMan probe  
5'-CCGTCTCGCTGCTGGTCCTCG-3'

SEQ ID NO: 31: forward *LUT1* primer  
5'-GGATGAATGAGTACGGACCCAT-3'

SEQ ID NO: 32: reverse *LUT1* primer  
5'-GGGTCGCTCACAATTACGAAA-3'

Figure 26a

SEQ ID NO: 33: CYP97A3 *Arabidopsis thaliana*:

MAMAFPLSYTPTITVKPVTYSRRSNFVVFSSSSNGRDPLENSVPNGVKSLLEKQEEKRRAELSARIASGA  
FTVRKSSFPSTVKNGLSKIGIPSNVLDFMFDWTGSDQDYPKVPEAKGSIQAVRNEAFFIPLYELFLTYGGI  
FRLTFGPKSFLIVSDPSIAKHILKDNAKAYSKGILAEILDFVMGKGLIPADGEIWRRRRRRAIVPALHQKYV  
AAMISLFGEASDRLCQKLDAAALKGEEVEMESLFSRLTLDIIGKAVFNDFDLSLTNDTGVI EAVYTVLREA  
EDRSVSPIPVWDIPIWKDISPRQRKVATSLKLINDTLDDLIATCKRMVEEEELQFHEEYMNERDPSILHFL  
LASGDDVSSKQLRDDLMTMLIAGHETSAAVLTWTFYLLTTEPSVVAKLQEEVDSVIGDRFPTIQDMKKLKY  
TTRVMNESLRLYPQPPVLIRRSIDNDILGEYPIKRGEDIFISVWNLHRSPLHWDDAEKFNPERWPLDGNP  
NETNQNFSYLPFGGGPRKCIGDMFASFENVVAIAMLIRRFNFQIAPGAPPVKMTTGATIHTEGLKLTVTK  
RTKPLDIPSVPIPLPMDTSRDEVSSALS

SEQ ID NO: 34: rice CYP97A *Oryza sativa*:

MAATSSAAAAAPPPCRLLGSGQAHLRLPPSAAAAAASARRRLLLRCAASGGNGKGGGGDGSGLPVEERRR  
RRQAEALARIASGEFTAQGPWAPIPLAVGLAKLGGPGLAAALLTKVAGGGGPEIPQAVGSMSAVTGQAFFI  
PLYDLFLTYGGIFRLNFGPKSFLIVSDPAIAKHILRDNASKAYSKGILAEILEFVMGTGLIPADGEIWRVRRR  
AIVPAMHQKYVTAMISLFGYASDRLCQKLDKAATDGEDVEMESLFSRLTLDVIGKAVFNDFDLSYDNGIV  
EAVYTVLREAEMRSTSPIPTWEIPIWKDISPRQKKVNEALALINKTLDELIDICKRLVEEEDLQFHEEYMNE  
QDPSILHFLLASGDDVSSKQLRDDLMTMLIAGHETSAAVLTWTFYLLSKYPNVMKQLQDEADTVLGDRLPTI  
EDVKKLKYTTRVINESLRLYPQPPVLIRRSIEEDMLGGYPIGRGEDIFISVWNLHHC PKHWDGADVFNPERW  
PLDGNPNETNQNF SYLPFGGGPRKCVGDMFATFETVVATAMLVRRFDFQMAPGAPPVEMTTGATIHTEGL  
KMTVTRRTKPPVIPNLEMKVISDSPENMSTTTSMPSAASIASGEDQQGQVSATRI

SEQ ID NO: 35: barley CYP97A *Hordeum vulgare*:

SARGQAVGSLASVAGEAFFLPLYDLFLTYGGVFRLNFGPKSFLIVSDPDVAKHILRDNASKAYSKGILAEILE  
FVMGTGLIPADGEVWRVRRRAIVPALHQKYVTAMIGLFGNASDRLCQKLDKAASDGEDVEMESLFSRLTLDV  
IGKAVFNDFDLSYDNGIVEAVYTVLREAEMRSTSPIPTWEIPIWKDISPRQRKVNEALALINNILDELIA  
TCKRMVDEEDLQFHEEYMNEKDPSILHFLLASGDDVSSKQLRDDLMTMLIAGHETSAAVLTWTFYLLSKYPN  
VMSKLQAEADAVLGDGLPTIDDVKKLKYTTRVINESLRLYPQPPVLIRRSLEDDMLGEYPIKRGEDIFISIW  
NLHRCPKHWDDADVFNPERWPLDGNPNETNQKFSYLPFGGGPRKCVGDMFATFETVVATAMLVKRDFDQMA  
PGAPPVEMTTGATIHTEGLNMTVTRRIKPPVIPNLEMKIVSDPEGSTSSSTASVAVSTASIASGEGQQVEVS  
TSQV

SEQ ID NO: 36: soybean CYP97A *Glycine max*:

GKGLIPADGEIWRVRRRAIVPALHQKYVAAMIGLFGQAADRLCQKLDAAASDGEDVEMESLFSRLTLDIIGK  
AVFNDFDLSLTNDTGIVEAVYTVLREAEDRSVAPIPVWEIPIWKDISPRLRKVNAALKFINDTLDDLIAICK  
RMVDEEELQFHEEYMNEQDPSILHFLLASGDDVSSKQLRDDLMTMLIAGHETSAAVLTWTFYLLSKEPRVMS  
KLQEEVDSVLGDQYPTIEDMKLKYTTRVINESLRLYPQPPVLIRRSLEDDVLGEYPIKRGEDIFISVWNLH  
RSPKLWDDADKFKPERWALDGPSPNETNQNF KYLPFGGGPRKCVGDLFASYETVVALAMLRRFNFQI AVGA  
PPVEMTTGATIHTEGLKMTVTHRIKPPVIPPSLQ MSTLEVDPSSISLSDQDEVSQKGEVYQAQAQS

SEQ ID NO: 37: wheat CYP97A *Triticum aestivum*:

GCRLPQAVGSLASVAGEAFFLPLYDLFLTYGGVFRLNFGPKSFLIVSDPDVAKHILRDNASKAYSKGILAEIL  
EFVMGTGLIPADGEVWRVRRRAIVPALHQKYVTAMIGLFGNASDRLCQKLDKAASDGEDVEMESLFSRLTLD  
VIGKAVFNDFDLSYDNGIVEAVYTVLREAEMRSTSPIPTWEIPIWKDISPRQCPKHWDADVFNPERWPL  
DGNPNETNQKFSYLPFGGGPRKCVGDMFATFETVVATAMLVKRDFDQMAPGAPPVEMTTGATIHTEGLNMT  
TVTRRIKPPVIPNLEMKIVSDSEGSTSSSTASVAVSTASIASGEGQQVEVSTSQV

**Figure 26b**

SEQ ID NO: 38: tomato CYP97A *Lycopersicon esculentum*:

QFPTHHYSKSRLLTSPKFKGSVSNFTIRCSNSNGKQPESVDEGVKKVEKLLDEKRRRAELSARIASGEFTVEQ  
SGFPSSLKNGLSKLGVPKFLEFFSRRTGNYPRIPEAKGSISAIRDEPFFMPLYELYLTGGIFRLIFGPKS  
FLIVSDPSIAKHILKDNSKAYSKGILAEILDFVMGKGLIPADGEIWRVRRRAIVPALHQKYVAAMIGLFGKA  
TDRLCCKLDVAATDGEDVEMESLFSRLTLDIIGKAVFNDFDSDLTVDTGIVEAVYTVLREAEDRSVAPIPVW  
ELPIWKDISPKLKKVNAALKLINDTLDDLIAICKRMVDEEELQFHEEYMNEKDPSILHFLLASGDEVSSKQL  
RDDLMTMLIAGHETSAAVLTWTFYLLSKEPSVMAKLQDEVDSVLGDRLPTIEDLKKLRYTTRVINESLRLYP  
QPPVLIRRSIEEDVVGGYPIKRGEDIFISVWNLHRCPNHWEEADRFPNPERWPLDGPNNETNQNFSYLPFGG  
GPRKCVGDMFATFENLVAVAMLVQRFDQFQMALGAPPVKMTTGATIHTTEGLKMTVTRRSRPPIVPNLEMATL  
EVD

SEQ ID NO: 39: green alga CYP97A3 *Chlamydomonas reinhardtii*:

ARRRAVVPALHRKYVMSMVDMFGDCAAHGASATLDKYAASGTSLDMENFFSRLGLDIIGKAVFNDFDLSLAH  
DDPVIQAVYTLLREAEHRSTAPIAYWNIPGIQFVVPQKRCQEALVLVNECLDGLIDKCKKLVEEEDAVFGE  
EFLSERDPSILHFLLASGDEISSKQLRDDLMTMLIAGHETTAAVLTWTLYLLSQHPEAAAAAIRKEVDELLGD  
RKPGVEDLRALKMTTRVINEAMRLYPQPPVLIRRALQDDHFDQFTVPAGSDFISVWNLHRSPKLWDEPDKF  
KPERFGPLDSPIPNEVTENFAYLPFGGGRRKCIGDQFALFEAVVALAMLRRYEFNLDESKGTVGMTTGATI  
HTTNGLN

Figure 27a

SEQ ID NO: 40: CYP97A *Arabidopsis thaliana*:

gtgatttgagttttttatgttgcggtggcggttgatggctatggcctttcctctttcttataactccgacgat  
tactgttaaaccagtaacgtactctcggagatcgaactttgtagttttctcgtcgagttctaattggacgag  
atccttttagaggagaattcagtacctaattggtgtgaaaagcttggagaagcttcaagaagagaagcgctcgt  
gctgagttatctgctaggattgcttctggagctttcactgtacggaaatctagttttccatctacagtga  
gaatggtttatctaagattggaataccaagcaatgttcttgatttcatgtttgattggactgggttctgacc  
aagactaccccaaggttctcgtaggctaaaggctcgattcaggcggtccggaacgaagctttcttcacccct  
ttgtatgagcttttcttacttatggtggaattttcaggttgacctttgggcctaagtcattcttgatcgt  
gtcggatccttctatttgctaaacatatattgaaggacaatgcaaaagcttactccaaggggatttttagctg  
aaattctagattttgtgatgggaaaaggactcattcctgctgatggggagatatggcgtagacgaaggcgt  
gccattgttctcgtcattgcatcaaaagtatgtagcagctatgattagtttattcggagaagcttcagatag  
gctttgtcagaagcttgatgctgctgcattgaaaggggaagaagtagagatggaatcactcttctcgtt  
tgacacttgatattattggcaaggcggttttcaattacgactttgactcccttactaatgataccggtgtg  
atcgaggcagtgtagactgttctaagagaagctgaagacagaagtgtttcacctattcctgtttgggacat  
accatttggaaagatatctccacgctcagaggaaagtgtacttcttgaaattaatcaatgacacac  
ttgatgatttgattgcaacatgcaagagaatggtagaagaaggaggttgacgtttcacgaggagtatatg  
aacgaaagagatcctagcatccttactttcttttagcttcaggagatgatgtctctagtaagcagcttcg  
tgatgacttgatgacaatgcttatagccggacatgaaacatcggcggcagtatcaacatggacctttacc  
ttttaacaacggaaccaagtgtagttgccaaacttcaagaagaggttgattctgtaattggagatagattc  
ccaaccatacaagatatgaaaaagctgaaatacactactcgagtcagatgaatgagtcattgagattatatcc  
acaaccaccagtactgatccgtcgttctatagataatgatatacttggagagtatccgataaaaaggggag  
aggatatcttcatctcggtttggaaatctacatcgaagtcctctgcattgggatgatgcagagaagttcaat  
cccagagatggcctttggatggaccaaaccctaatgagacaaaccaaacttcagttacttacctttcgg  
tggaggaccgcggaatgtataggcgacatgtttgcttcttggagaatgtggttagcaatcgcaatgctta  
ttcgaagatttaactttcagattgcaccaggagctcctcgggtgaaaatgactacaggagctacaatacac  
accacagaaggattgaaattgacagtaacaaaggagacaaaacctctggacataccatccgtaccgatact  
tccaatggatacttcacgggatgaagtttcatctgctcttctttaaagtcttcatctttacaaaactgaaaa  
caaacaagctcagatgaagaagcaaaaatcttggtgttagaacagcaaatgttgaattggttggaaatgacc  
aatgctttctgatttttctgctgactgtaaaatgcagacaagttaaatagagaagatttattattcttgg  
aaaaaaaaaattgttttctgctgcacagtgaagataataaacttctgggttctatgtaaaaaaaaaac

Figure 27b

SEQ ID NO: 41: CYP97A *Arabidopsis thaliana*:

atggctatggcctttcctctttcttatactccgacgattactgttaaaccagtaacgtactctcgagatcg  
aactttgtagttttctcgtcgagtttctaattggacgagatccttttagaggagaattcagtacctaattggtgtg  
aaaagcttggagaagcttcaagaagagaagcgtcgtgctgagttatctgctaggattgcttctggagctttc  
actgtacggaaaatctagttttccatctacagtgaagaatggtttatctaagattggaataccaagcaatggt  
cttgatttcatgtttgattggactggttctgaccaagactaccccaagggttcctgaggctaaaggctcgatt  
caggcgggtccggaacgaagctttcttcatccctttgtatgagcttttccttacttatggtggaattttcagg  
ttgacctttgggcctaagtcattcttgatcgtgtcggatccttctattgctaaacatatattgaaggacaat  
gcaaaagcttactccaaggggatttttagctgaaattctagattttgtgatgggaaaaggactcattcctgct  
gatggggagatatggcgtagacgaaggcgtgccattgttcctgcatgcatcaaaagtatgtagcagctatg  
attagtttattcggagaagcttcagataggctttgtcagaagcttgatgctgctgcattgaaaggggaagaa  
gtagagatggaatcactcttctctcgtttgacacttgatattattggcaaggcggttttcaattacgacttt  
gactcccttactaatgataccgggtgtgatcgaggcagtgtagactgttctaagagaagctgaagacagaagt  
gtttcacctattcctgtttgggacatacccatgttgaaagatatccccacgtcagaggaaagtgtgctact  
tccttgaaattaatcaatgacacacttgatgatttgattgcaacatgcaagagaatggtagaagaaggaggag  
ttgcagtttcacgaggagtatatgaacgaaagagatcctagcatccttcactttcttttagcttcaggagat  
gatgtctctagtaagcagcttcgtgatgacttgatgacaatgcttatagccggacatgaaacatcggcggca  
gtattaacatggaccttttaccttttaacaacggaaccaagtgtagttgccaaacttcaagaagagggttgat  
tctgtaattggagatagattcccaaccatacaagatatgaaaaagctgaaatacactactcgagtcatgaat  
gagtcattgagattatatccacaaccaccagtactgatccgtcgttctatagataatgatatacttgggagag  
tatccgataaaaaggggagaggatatcttcatctcggtttggaaatctacatcgaagtcctctgcattgggat  
gatgcagagaagttcaatcccggagagatggcctttggatggacaaaacccaaatgagacaaaacaaaacttc  
agttacttacctttcgggtggaggaccgcggaaatgtataggcgacatgtttgcttcctttgagaatgtggta  
gcaatcgcaatgcttattcgaagatttaactttcagattgcaccaggagctcctccggtgaaaatgactaca  
ggagctacaatacacaccacagaaggattgaaattgacagtaacaaaggagacaaaacctctggacatacca  
tccgtaccgatacttccaatggatacttcacgggatgaagtttcatctgctcttttcttaa

Fig. 27c

SEQ ID NO: 42: rice CYP97A *Oryza sativa*:

atggcggctacctcctctgcgccgcccgtgctccacctccgtgcccgttactcgggtccgggtcaggcacac  
ctgcgcccttctccttctgctgctgctgctgctgctcagctcgtcgccgctgctcctccgctgcccgc  
tcggcgcggaacgggaagggcgtggtggcgacgggtccgggtccgacccgggttcttgaggagcggcgcg  
cggcgccagggtgagctggcgcgcgcatctgctccggcgagttaccgcccaggccccgcgtcagtgctc  
attctctctctctctctctctcacgttgcgccgcctttccttctcctttgatgatctgatggagagctcc  
ctctctctttttcagggtgattgctccccctcgcggtggggcttgccaagctcggcccaccgggggagctcgc  
cgccgcgtgctcaccaaggctcgccggtggcgcgacccggagataccgcaggcgggtggggctctatgagtgc  
ggtgacagggcaggctttcttcatcccgctctatgatctcttcttacctatggcggcattcttcgcctcaa  
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taagcacatcctgagggacaactccaaggcttattccaaggttttgtgtgtgtcaattttggatgtagacgtg  
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tgtaccagcaatgcaccagaagggttctacatcatttctgtaccagggttagcatgatttgatcttcgggttg  
tgattgaactgatctgaatttcgctttgcagtacgttaccgcaatgataagtctcttcggatatgcttcaga  
tcggctctgccagaagttggacaaggcagcaacggatggggaggatgtggagatggaatctttgttctctcg  
actaacactggatgtcattgggaaggcagctctcaattatgatttcgactcattgtcttacgataatggaat  
agttgaggttagtattcagctctgtactgtaattttggaattcattatacattctattttgttcatgtttgtt  
ttcttaaaattttaccttttttggattgatgatcaggcagtgatgtgacactgcgagaagcagaaatgcg  
gagcacttctcctataccaacttgggaaataccatattggaagataatttccccgcggcagaagaaggtcaa  
tgaagctcttgcgctgataaataagactcttgatgaactaattgacatctgcaagggtgaacttcttttctta  
tgttctgacctattatttttttaaaaaaatcaaggcttttagattggctgctgttactcttgacagaga  
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ttgctggccatgagacctctgcagcagctcttgacatggacattttatcttctatctaagggtatcaatatgtt  
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taatggccaaactccaagatgaggtaaattcgcttttaccatttaggattgttatttttagaggcacgtgctt  
ctacatcttacaagttgcaaatgacttgtttcactcaacttatggacaggctgatactgttctaggtgacct  
ttaccaacaattgaggatgtgaagaaattgaagtatactactagagtaattaacgaagtaagtataaacag  
tgctacctcattaaacaatgagtatgatcactgaatgaatatgtcattcaatcaccacttttgcagtcattg  
agactctatccacagccaccagttttaattcgctcgtctatttgaggaggatatgctgggagggtacccaatt  
ggccggtaaagaaaaactctagcagaacttatttctcaagtgtaggaaatctctcctgtagtctgttgactg  
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gttgtgttcttgtttgacgagaagtttgcgtttttacatctactaacactaagttatttgggtcatgcatgc  
acctgttgtaattattctagagataacaaaaacaaaactctagctgatttttcgttttcttctttgatgcaa  
atcatcaaattttcttcatgtgattcgtattaatttagtgctaagtgtggcatgtgcatagccacaactcta  
gaaagtgcataaggcagtcacaacaacataaagaaaaatgggaccttttcttttgaagcagtaaaagatgag  
ataactgtgatgacttgattcctaaatttatgggttttgggagctaaaccacagtttatgacaatcatgttaa  
aatgatattcatatggctataagcaacatgtgccaaaatgctattgtactttcaaaactgatagtgcctgaaa  
gtacttttcaactttaccacatcgccagaactgttaactgggttacgcagaaacagtaacttggaaatagtaatt  
ttgtataaactgatagtatgtcgatgagttccttacctgtagcaagtatgtcaacagcagaaccttttgta  
tggatcaacaaacatcagaggtgctttgaacaaaatccttacttgattagaagacgtaacaattcgtgccat



**Figure 27d**

cctgagttaatgaagacttccgactggactacaaacttcttccgtgttgagtccttgaggagttgatgca  
cggcataaaacctgtgacctgcaaatcatgttaattgaaaaacaaccaacgtatcatcaactataatgtaca  
gcaagtctcctagggcatcacactgaaacttaaaaatggtaatctgcatttacttggcacatgacatgtccca  
ttattttgtcagcttagattgaactcactgcggaacacatcttctttcaagacaacatccaaattattgat  
tttcagttggcatgtcaaaactttttaagctccaatttttaggctgtggttagctttcattctgtgtattgcggc  
tagcatctgttagctgtcactgcctcactggctaatttaatatatttgatgaatctacatagctaaatggga  
ctcacgtgttctgttgaattctcagttacttgccatttggtggcggaccaaggaaatgtgtaggtgacatgt  
ttgccactttcgaggtaatttggttttagttttgaaggatttcttcttttaatttcaaaatgtcattttaag  
gaaacatagcaaaacttatgtatgggccagtcttactgaaccttggtgccttgagccttctgttgtctacat  
aaggacattatatctcatgccatgataaataatgtagtacaataactattgagcatgcaagattccaactct  
aataacatggatatgccggaacttgatgcagactgtggtggcaactgcaatgcttgtcaggcgctttgatt  
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agataatcactgtgaagtatcaatatgataggttgagatgacaactggagcaacgattcacacaactgaggg  
gttgaaaatgactgttactcgaggacaaagccacctgtaatcccaaaccctagagatgaaagtcatttctga  
ttcaccagaaaacatgagtactactacatcaatgccggttctgtctgctagtattgcttcaggagaagatca  
acaagggcaagtctcagcaactcgaatctga

Figure 27e

SEQ ID NO: 43:      rice CYP97A *Oryza sativa*:

atggcgcgctacctcctctgctggcgcgcgctgctgccacctcgtgcgcttactcggtccgggtcaggcacac  
ctgcgcccttccctccttctgctgctgctgctgctgcttccagctcgtcgccgctgctcctccgctgcgccgcc  
tcgggcgggcaacgggaaaggcggtggtggcgacgggtccgggtccgaccgggttcttgaggagcggcgggcg  
cggcgcacaggctgagctggcgcgcgcatattgcgtccggcgagttaccgcccgaaggccccgcgtggattgct  
cccctcgcggtggggcttgccaagctcggcccaccgggggagctcgccgcccgcgtgctcaccaaggctcgcc  
ggtggcgggcggaaccggagataaccgcaggcggtggggcttatgagtgcggtgacagggcaggctttcttcac  
ccgctctatgatctcttccctaacctatggcggcattcttgcctcaatttcggccctaagtctttcctcatt  
gtctctgatccagctatagctaagcacatcctgagggacaactccaaggcttattccaagggtattctggca  
gaaatttttagagtttgatgggtacgggtttgatccctgctgatggggagatttggcggtttaggaggcgc  
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cactggatgtcatttgggaaggcagctctcaattatgatttcgactcattgtcttacgataaatggaatagtt  
gaggcagtgatgtgacactgcgagaagcagaaatgcggagcacttctcctataccaacttgggaaatacc  
atatggaaagatatctcccgcggcgagaagaaggctcaatgaagctcttgcgctgataaataagactcttgat  
gaactaattgacatctgcaagagattggctcgaggaagaagatctgcagtttcatgaagaatacatgaatgag  
caagaccccgatctctccactttcttttggcatctggagatgatgtctccagcaagcaactccgctgatgat  
ctgatgacaatgctcattgctggccatgagacctctgcagcagctcttgacatggacattttatcttctatct  
aagtatccaaatgtaatggccaaactccaagatgaggctgatactgttctaggtgaccgtttaccaacaatt  
gaggatgtgaagaaattgaagtatactactagagtaattaacgaatcattgagactctatccacagccacca  
gttttaattcgctcgctctattgaggaggatgatgctgggagggtacccaattggccgggggagaagacattttc  
atatccgctgtggaacctacatcattgccc aaagcattgggatgggtgcagatgtttttaatccagaaagatgg  
cctttggatggaccaaatccaaatgaaacaaacccaaatttcagttacttgccatttgggtggcggaaccaag  
aatgtgtagggtgacatgtttgccatttcgagactgtggtggcaactgcaatgcttgcaggcgcttttgat  
tttcaaattggctccaggagctcctccggttgagatgacaactggagcaacgatccacacaactgaggggttg  
aaaatgactgttactcggaggacaaaggccactgtaatccaaacctagagatgaaagtcatttctgattcca  
ccagaaaacatgagtactactacatcaatgcccggtttctgctgctagtattgcttcaggagaagatcaacaa  
gggcaagtctcagcaactcgaatctga

SEQ ID NO: 44: CYP97A barley *Hordeum vulgare*:

ctcgacacgagggcagggcgcgtcgggctcgctggcttccgctgcgggggaggccttcttctcgccgtctacgac  
ctcttctcctacctacggcggcgtcttccgcctcaacttcggggcccaagtcttctctcatcgctctctgatccg  
gatgtagctaaagcatatcctcagggacaactcaaaggcttattccaagggtatccttgcggaaatactggag  
tttgtgatgggcacaggtctgatcccggtgatggggagggtctggcggtgttcgacggcggtgccatttgtacca  
gcattgcatcagaagtacgtgacagcgatgataggtctctttggaaacgcttcagaccggctctgccagaag  
ctcgacaaggctgcttcggacggggaggatgtggagatggaatctctcttctcccgactaacgctggatgtc  
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tgtaacactgcgggaagcagaaatgcggagtacatctcctattccaacatgggaaatacccatatggaaag  
acatctccccctcggcagaggaagggtcaatgaagcgcttgactgataaataatattctcgatgaactaatt  
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taattcgccgctcccttgaggatgatatgctaggagagtagccgatcggcaaggggagaagatatttttatat  
ccatctggaaccttcatcgctgccc aaagcattgggatgacgcggatgttttcaatcgggaaagggtggcctt  
tggacgggaccgaatccaaatgagacaaacccaaaaattcagttacttgccatttgggtggcggaaccaaggaat  
gtgtagggtgatattgtttgctacttttgagactgtggtagcaacagcaatgcttgtcaagcagatttgattttc  
agatggctccaggagacctccggtcgagatgacaaccggagcaacgattcacacaactaagggaactgaaca  
tgactgttactcggaggataaaagccacctgttaattccaaacttagagatgaaaatcggttccgatccagaag  
gaagcacaagttctactgcgtcagtggtgttttctactgctagtattgcatccggagaagggtcaacaagtg  
agggtgcgacaagtc aaagtgta

**Figure 27f**

SEQ ID NO: 45: soybean CYP97A *Glycine max*:

gggaaagggccttatcccagctgatgggtgaaatatggcgagtttagacgtcgtgctatagtcacagcattgcac  
cagaagtatgtagcagctatgattggccttttcggacaagctgcagataggctctgccagaagctagatgct  
gctgcatccgatggagaagatggtgagatggaatcacttttctctcgattgaccttggacatcattggcaag  
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agagaagcagaagatcgaagtgttgctccaattccagctctgggagatcccaatatggaaagacatatcacca  
cgtctaaggaaggttaatgcagctctcaaattcatcaatgatacgcttgatgatctgatagcaatatgcaag  
agaatgggtggatgaagaagagttacagtttcatgaggagtacatgaatgagcaagatccaagtattctacac  
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aagctccaagaagaggttgactctgtacttggagatcaatatccaactatagaagacatgaagaaactcaaa  
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gaggatgatgttcttggagagtaccctataaagagaggtgaagatatctttatatctgtatggaacctgcat  
cgagtccaaaaactaatgggatgatgctgacaagttttaaacctgaaagatgggcattagatggaccaagtcct  
aatgagacaaatcaaaacttcaaatatcttccgtttgggtggcgaccacggaaatgtgtagggtgatttgtt  
gcttcatacgagacggttagtagcactcgcaatgcttatgagacgattcaactttcaaatagcagttggagct  
ccaccggttgagatgactactggagctacaattcatacaacacaaggggtgaagatgactgttaactcacaga  
ataaaaacctcctattgtgccctcattacagatgtcaactttggaagtggatccatccataagcctttctgat  
caagatgaagtaagtcagaaaaggcgaagtttaccaggctcaggctcagtcctaa

SEQ ID NO: 46: wheat CYP97A *Triticum aestivum*:

Ggctgcaggctgccgcaggcggctcgggtcgtggcgtccgtcgccggggaggccttcttctcgtccgctctac  
gacctcttctcacctacggcggcgtcttccgcctcaacttcgggccaagtcttctctcatcgtctctgat  
ccgatgtagctaagcatatcctgagggacaactccaaggcttattccaagggtatccttgcggaaatattg  
gagtttgtgatgggacaggtctgatccggctgatggggaggtctggcgtgttcgacggcgtgccattgta  
ccagcattgcatcagaagtacgtgacagcgatgataggtctcttcggaaatgcttcagaccgtctgtgccag  
aagctggacaaggcggcatccgatggggaggatgtggagatggaatctctcttctctcgactaacgctggat  
gtcatcgggaaggcagtggtcaattatgattttgattcattatcttacgataatggaatagttgaggctgtg  
tatgtaacattacgggaagcggaaatgcggagcacatctcctattccaacttgggaaataccatagggaaa  
gacatctcccctcggcagagtgcccaaagcattgggacgatgcggatgttttcaatccagaaagggtggcctt  
tggacggaccgaatccaaatgagacaaacaaaaattcagttatttgccatttgggtggcgggccaaggaaat  
gtgtaggcgatatgtttgctacttttgagactgtggtggcaacagcaatgcttgtcaagcatttgattttc  
agatggctccaggagcacctccggctcgagatgacaactggagcaacgattcacacaactaagggactcaaca  
tgactgttactcggaggataaaagccacctgtaattccaaacttagagatgaaaatcgtttccgattcagaag  
gaagcacaaagttctactgcgtcagtggtgttttctactgctagtattgcatccggagaagggtcaacaagtag  
agggtgctgacaagtcaagtgtga

Figure 27g

SEQ ID NO: 47: tomato CYP97A *Lycopersicon esculentum*:

caatttccaacacaccattactctaaatctagactcactctctcacctaaattcaagggtagtgtatcaa  
tttacaattaggtgttctaattctaattggaaaacagcctgagtcggttagatgaaggagtcaaaaagggtggaa  
aagcttttagatgagaaaaggcgagctgaattatctgctcgatttgcttcaggcggaatttactgttgaacaa  
tctggcttcccgcatttgctcaaaaatggtttgtctaaattgggtgtaccaaaaggaatttcttgagttcttc  
tctcgacgaacgggcaattatcctcgcatccagaggcaaaaaggatccatcagtgctattcgggatgagcca  
ttcttcatgcccgtttatgagctttaccttacttatggcggaattttccggttgatttttgggtcccaagtct  
tttttaatagtttctgatccatcaatagccaaacacatactgaaagataattctaaggcttattctaagggt  
atcctagctgaaatattggactttgtgatgggaaagggttatacctgcagatggagaaaatttggcgctc  
aggcggtggtgcatgtaccagcattgcacaaaagtacgtagcagctatgattggcttatttggaaaagca  
accgatagggttgcaaaaagcttgatgttgctgcaactgatggagaagatgtagagatggaatcacttttc  
tccgctcaacattggacatcattggcaaaagctgtatttaattatgattttgactctttaactgtagatact  
ggtatcggtggaggctgtatatacagctacttagagaagcagaagatcgtagtggtgcaccaattccagtttgg  
gagttgcctatctggaaaagatatctctccgaagctaaaaaagggttaatgcagctctcaagttgattaatgac  
acattggatgatctgattgctatatgtaagaggatggtagacgaagaagagttgcagtttccagaggaatac  
atgaatgaaaaagatcctagcatcctccatttcttgtagcatctggagatgaggtctcaagcaagcaactt  
cgtgatgacctcatgacaatgcttatagcgggacatgaaacatctgcagcagtgctcacatggacctttat  
ctgttggtccaaggaacctagtgtcatggccaagcttcaagatgaggtcgattcagttctaggggataggta  
ccaaccattgaagatctaaagaaactcagatacacaaactcgtgtgattaatgagtccttaagactatatcca  
cagccaccagtccttgattcgctgcttctattgaagaggacgtagttggagggttaccgattaaaaggggtgaa  
gacattttcatttctgtttggaacttgcatcgatgccgaatcattgggaagaagccgatagattcaatcct  
gagaggtggccacttgatggacctaacccaaatgagacgaacaaaatttcagttaccttcccttcggtggt  
ggaccaagaaaatgtgtgggagacatgtttgccacatttgagaatttagtagcagttgcaatgcttgttcaa  
cgatttgattttcaaatggctcttgaggctcctcctgttaaaatgacaactggggctaccatccacaccaca  
gaaggattaaaaatgactgtaacacgaagatcaagacctccaatagttcccaacttgagatggcaacatta  
gaagtagat

SEQ ID NO: 48: CYP97A like gene *Chlamydomonas reinhardtii*:

gcgcgcgcgcgcagtggtgccagccctgcaccgcaagtacgtgatgtcgatggtggacatgttcggcgac  
tgccgcggcgacggcgcgctccgccacactagacaagtatgccgcctcaggcaccagcctggacatggaaaac  
ttcttcagccggctgggtctggacatcatcggaaggccgtgttcaactacgacttcgactcgctggcgac  
gacgacccgtcatccaggccgtgtacacgttgctgcccgaagcggagcaccgctccacagcggccatcgcc  
tactggaacattcccgcatccagtttgtggtgccgcggcagaagcgtgccaggaggcgctggtgctggta  
aatgagtgccctggacggcctcatcgacaagtgcagaagctgggtcgaggaggaggacgcggtgtttggggag  
gagttccttagcgagcgcgacccctccatcctgcacttctcctcgctctggagacgagatttctcgaag  
cagttgcgcgatgacctgatgactatgctgattgcggggcacgagaccaccgcccgtgctgacgtggacg  
ctgtacctgctgtcccaacaccccgaggcggcagcgccatccgcaaggaggtagacgagctccttggggac  
cgcaagcccggggtggaagacctcagagcgtcaagatgacgactcgctcatcaacgaggcgatgcccgtc  
taccacagccgcccagctactcattcgccgcgcgtgcaggacgaccacttcgaccagttcacggtgccggcc  
ggcagcgacctgttcatcagcgtgtggaacttgaccgcagccctaagctgtgggacgagcccgaagttc  
aagccggagcgcttcggaccgctggacagcccatcccaacgaggtgactgaaaacttcgcctacctgcc  
tttggcggtggccgcccgaagtgcattggcgaccagttcgctttgttcgaggcggttgttgcgctggccatg  
ctgatgcggcgatagcaggttcaacctggacgagtcgaaggggacagtgggcatgacaacaggtgccaccatc  
cacaccaccaacggtctaaac

Figure 28

SEQ ID NO: 49: CYP97B3 *Arabidopsis thaliana*:

MAFPAAATYPHTFQGGALHLGRTDHLFGFYPTISSVNSRRASVSIKCQSTEPKTNGNILDNASNLLTNF  
LSGGSLSGSMPTAEGSVSDLFGKPLFLSLYDWFLEHGGIYKLAFGPKAFVVISDPIIARHVLRENAFSYDKG  
VLAIEILEPIMGKGLIPADLDTWKLRRRAITPAFHKLYLEAMVKVFSDCSEKMILKSEKLIREKETSSGEDT  
IELDLEAEFSSLALDIIGLSVFNDFGSVTKESPVIAVYGTLFEEAHRSTFYFPYWNFPARWIVPRQRK  
FQSDLKIINDCLDGLIQNAKETRQETDVEKLQERDYNLKDASLLRFLVDMRGVDIDDRQLRDDLMTMLIA  
GHETTAAVLTWAVFLLSQNPEKIRKAQAEIDAVLGQGPPTYESMKLEYIRLIVVEVLRLFPQPPLLIIRRT  
LKPETLPGGHKGEKEGHKVPKGTDIFISVYNLHRSPIYFWDNPHDFEPEFLRTKESNGIEGWAGFDPSPSP  
GALYPNEIIADFAFLPFGGGPRKCIGDQFALMESTVALAMLFQKFDVELRGTPESVELVSGATIHAKNGMW  
CKLKRRSK

SEQ ID NO: 50: pea CYP97B1 and CYP97A2 *Pisum sativum*:

MVAAPISTVKLTDANLHTRFHSSSSSTPSTLSLPLSLHFHSSHSKRFSIRCQSVNGEKRKQSSRNVFDN  
ASNLLTSLLSGANLGSMPAIEGAVTDLFDRLFFSLYDWFLEHGSVYKLAFGPKAFVVVSDPIVARHILRE  
NAFSYDKGVLAIELEPIMGKGLIPADLETWKQRRRVIAAPGFHTSYLEAMVQLFTSCSERTVLKVNELLEGE  
GRDGQKSVELDLEAEFSNLALIEIIGLVFNDFGSVTNESPVIAVYGTLFEEAHRSTFYIPYWKFLARW  
IVPRQRKFQDDLVINTCLDGLIRNAKESRQETDVEKLQORDYSLNKDASLLRFLVDMRGVDVDDRQLRDD  
LMTMLIAGHETTAAVLTWAVFLLAQNPDKMKKAQAEVDLVLMGKPTFELLKKLEYIRLIVVETLRLYPQP  
PLLIRSLKPDVLPGGHKGDGDYTIIPAGTDVFIISVYNLHRSPIYFWDNPDPFEPERFLVQNNNEEVEGWAG  
FDPSPSPGALYPNEIISDFAFLPFGGGPRKCVGDQFALMESTVALVCCYRISMWN

SEQ ID NO: 51: soybean CYP97B2 *Glycine max*:

MSVDTSSSTLSTVTANLHSRFRHSLVPFTHHFSLSQPKRISSIRCQSINTDKKKSSRNLLGNASNLLTDLL  
SGGSIGSMPIAEGAVSDLLGRPLFFSLYDWFLEHGAIVYKLAFGPKAFVVVSDPIVARHILRENAFSYDKGV  
LADILEPIMGKGLIPADLDTWKQRRRVIAPAFHNSYLEAMVKIFTTCSERTILKFNKLEGEYDGPDSIE  
LDLEAEFSSLALDIIGLVFNDFGSVTKESPVIAVYGTLFEEAHRSTFYIPYWKIPLARWIVPRQRKFQ  
DDLKVINTCLDGLIRNAKESRQETDVEKLQORDYSLNKDASLLRFLVDMRGADVDDRQLRDDLMTMLIAGH  
ETTAAVLTWAVFLLAQNPDKMKKAQAEVDLVLTGRPTFESLKELOIYIRLIVVEALRLYPQPPLLIIRSLK  
SDVLPGGHKGEKGDYAIIPAGTDVFIISVYNLHRSPIYFWDNPDPFEPERFLVQNKNEEIEGWAGLDPSPSPGA  
LYPNEVISDFAFLPFGGGPRKCVGDQFALMESTVALTMLLQNFDELKGTPESEVELVTGATIHTKNGLWCN  
LKRSSLH

SEQ ID NO: 52: rice CYP97B4 *Oryza sativa*:

MAAAAAAIVPCVPFLCPPPPPLVSPRLRRGHVRLRLRPPRSSGGGFTGGGGAGGDEPPITTSWVSPDWLTA  
LSRSVATRLGGDDSGIPVASAKLDDVRDLLGGALFLPLFKWFREEGPVYRLAAGPRDLVVVSDPAVARHV  
LRGYGSRYEKLVAEVSEFLFGSGFAIAEGALWTVRRRSVVPVSLHKRFLSVMVDRVFCKCAERLVEKLETS  
ALSGKPVNMEARFSQMTLDVIGLSLFNFDLSLTSDSPVIDAVYTALKEAELRSTDLLPYWKIDLLCKIVP  
RQIKAEKAVNIIRNTVEDLITCKKIVDAENEQIEGEEYVNEADPSILRFLASREEVTSVQLRDDLLSML  
VAGHETTGSVLTWTIYLLSKDPAALRAQAEVDRVLQGRLPYEDLKELKYLKRCINESMRLYPHPPVLIR  
RAIVDDVLPNGYKIKAGQDIMISVYNIHRSPEVWDRADDFIPERFDLEGVPVNETNTEYRFIPFSGGPRKC  
VGDQFALLEAIVALAVVLQKMDFTIELVPDQKINMTTGATIHNTNGLYMNVNIGVQVDEARKHGYNSFIV  
YGYTLAYISPRIWSAMPVL

**Figure 29a**

SEQ ID NO: 53: CYP97B3 in *Arabidopsis thaliana*:

atggcttttctgcccgtgctacttatcccacccatttccaaggcgcgctcttcatctgggtaggaccgat  
cattgcctcttcggtttctaccctcaaaccatttctctgtgaattctcggagagcttctgtttccatcaag  
tgccaatctacggagccaaagacgaatggtaacatattggacaatgcgagcaaccttttgacaaatttttta  
agtgggtggaagtttgggggtcaatgcctactgctgaaggctctgtctctgatttgtttggaaagcctctctt  
ttatctctttacgactgggttcttggagcatggaggaatttataaaacttgcgtttgggtccaaaagccttgg  
gtcatctcagatcccattatttgaaggcatgtcctccgggaaaaatgctttttcttatgacaagggaagttctt  
gctgagatcttagagccgattatgggaaaagggttaataccggctgatctagatacgtggaagttaagaaga  
agagctatcactcccgcatccataaaattgtatctagaggccatggtcaaagtatttagtgactgttcggag  
aaaatgatattgaaatctgagaaactcataagggagaaagaaacttcaagcggggaggacaccattgagttg  
gatctggaagcagaattctcagatctggctcttgatattataggcttagcgtgttcaactacgatttttggc  
tctgtcacaaaagagctccctctgtgatcaaggcagtttatggaactcttttcgaggcagacatcggctctact  
ttctacttcccttattggaactttctccagctagatggatagttccgaggcaacgaaagttccaaagcgat  
ctgaagattataaaacgattgccttgatggcctcattcaaaatgctaaagagacaagacagcaggaaacagat  
gttgagaagctccaggaaagggaactacactaatctcaaggatgcaagtcttttgcggttcttagtcgatatg  
cgcggtgttgacattgatgaccggcagctgagggatgacttgatgactatgctaattgctgggtcatgagaca  
acagcagcagctacttacttgggctgttttcttctgtcacaaaatcctgaaaaaattaggaaagctcaagct  
gagattgatgctgtgcttgggtcaagggtccacccttatgaatcaatgaaaaagctcgagtacatacagctg  
atcgtttagaagtccttctgtctcttctcctcagccacctttgctcatcagacgcactctcaaaccagaaaca  
ttaccgggtggacacaaaagggaaggtcataaagttccaaaagggaactgatattcttcttctgtga  
tataatctccatagatctccatacttttgggataatcccacgattttgagcctgagaggtttttaagaaca  
aaggagagcaatggaattgaaggatgggctggctttagccatctcgtagccccggggcactatatccgaat  
gagataatagcagactttgcattcttaccatttgggtggaggaccaagaaaatgcattggagaccagtttgca  
ctaattggaatcgaccgtcgactagctatgttgtttcagaaattcgatgtggagctgcgtggaacgccagaa  
tctgttgaaactcgtgagcggcgcaacgattcatgccaaaaatgggatgtggtgcaactaaagagaagatca  
aagtga

SEQ ID NO: 54: CYP97B1 and CYP97A2 for *Pisum sativum*:

catcacttaccactaactgaaacttgcaagcaccattctcaacttaacaccgctcgtcaccgccatgggttgc  
cgccccctattcaaccgtcaaacttaccgatgccaatcttcacaccagatttcttctcttcttctta  
caccatccaccctcagctcttccactctctcttcttcttcttcttcttcttcttcttcttcttcttct  
atcagatgtcaatcggttaagtgggtgaaaagcgaaaacaaagtagtagaaatgtgtttgacaatgctagcaa  
cctccttacaagcttgttaagtgggtgcaaatttaggggtccatgcccatagctgaagggtgccgtcacagatc  
tgtttgaccggcgcgtgtttttctcactatatgattgggttcttagagcatggttctgtgtataaaactggcg  
tttggaccgaaagcatttgttgtgtatcagatccattgttgaagacataattctgcgagaaaatgcatt  
ttcttatgacaagggaagtagtctgctgatattctagaaccaattatgggaaaagggaactcatacctgcagacc  
ttgagacatggaagcaaaggagaagagtgattgctccgggtttccatacctcatacttggaaagctatggta  
caactattcacttcatgttcagaaagaactgtgttaaagggtcaatgagcttcttgaaggagagggggcgtga  
tggaacagaagtcagttgaattggaccttgaggcagaattttcaaatttgggtcttgagattattgggctag  
gtgtgttcaactatgactttgggtctgtcaccaatgaatctcccgttattaaggctgtctatggcactctt  
tttgaagccgaacatagatccactttctatattccatattggaaatttccattagcaagggtggattgtgcc  
caggcaaaggaagtttcaggatgaccttaaagtcattaatacttgtcttgatggacttatcagaaatgcaa  
aagagagcaggcaggaaacagatgttgagaaactgcagcaaaagggaattactcaaatttgaaggatgcaagt  
cttctgcgtttcttagttgatatgccccgagttgatgttgatgatcgtcagttgagggatgatttaatgac  
aatgcttattgctggtcatgagacgacggctgcagttcttacatgggcagttttctgctagctcaaaatc  
ctgacaaaatgaagaaggctcaagcagaggtagatttgggtgctggggatggggaagccaacttttgaattg  
cttaaaaagttggagtacattagggttaattgttgggtgagactcttcgattatatccacaaccacctctgct  
gattagacgttcaactcaaacctgatgttttgcagggtggacataaagggtgacaaagatgggttatatacaatc  
ctgctgggactgatgtcttcttctgtatatcaacttccatcgatctccatatttttgggacccgctaat  
gacttcgagcctgaacgatttctagtgcaaaacaataatgaagaagttgaagggtgggtgtgtttgaccc  
atctcgaagtcctggagccttgtatccaaacgagattatatcagattttgcattcttgccttttgggtggtg  
gaccacgaaaatgcgttggagaccaatttgcctcctatggaatccactgtagcgttagtatgctgctacaga  
atttcgatgtggaactgaaggggacccctgaatcggttgaactagttactggggcaactatccataccaaa  
aatggattgtgggtgcaatttggaggaagagatctagtttacattgacatgttaactgcaacatttttcttat  
gcagaatgatgtacaaaatatttatcattttaaataatgacattaacattgaatagtgcttaatacagctaaag  
ggtatttac

**Figure 29b**

SEQ ID NO: 55: soybean CYP97B2 Glycine:

atgagtgtcgacacttccctccaccctctccaccgtcaccgatgccaatcttcactccagatttcattctcg  
tcttggtccattcactcatcatttctcactttctcaacccaaacggatttcttcaatcagatgccaatcaa  
ttaataccgataagaagaaatcaagtagaaatctgctgggcaatgcaagtaacctcctcacggacttatta  
agtgggtggaagtataggggtctatgcccatagctgaagggtgcagtctcagatctgcttggtcgacctctctt  
tttctcactgtatgattgggttcttgggagcatggcggtgtataaaacttgcccttggacaaaagcatttg  
ttgttgatcagatcccatagttgctagacatattctgcgagaaaaatgcattttcttatgacaagggagta  
cttgctgatatccttgaaccaataatgggcaaaggactcataccagcagaccttgatacttggaaagcaaag  
gagaagagtcattgctccggctttccataactcatacttggaaagctatgggttaaaatattcacaacttggt  
cagaaagaacaatattgaagtttaataagcttcttgaaggagaggggttatgatggacctgactcaattgaa  
ttggatcttgaggcagagttttctagtttggctcttgatattattgggcttgggtgtgttcaactatgactt  
tggttctgtcaccaaagaatctccagttattaaggcagctctatggcactctttttgaagctgaacacagat  
ccactttctacattccatattggaaaattccattggcaagggtggatagtcccaaggcaaagaaagtttcag  
gatgacctaaagggtcatcaataacttgtcttgatggacttatcagaaatgcaaaagagagcagacaggaaac  
agatgttgagaaattgcagcagagggattacttaaatttgaaggatgcaagtcttctgcgtttcttggttg  
atatgcggggagctgatgttgatgatcgtcagttgagggatgatttaatgacaatgcttattgccggtcat  
gaaacaacggctgcagttcttacttgggcagttttctcctagctcaaaatcctagcaaaatgaagaaggc  
tcaagcagaggttagatttgggtgctgggtacggggaggccaacttttgaatcacttaaggaattgcagtaca  
ttagattgattgttggagggtctctcggtttatacccccaaccacctttgctgattagacgttccactcaa  
tctgatgttttaccaggtgggcacaaagggtgaaaaagatgggttatgcaattcctgctgggactgatgtctt  
catttctgtatataatctccatagatctccatatttttgggaccgccctgatgacttcgaaccagagagat  
ttcttgtgcaaaacaagaatgaagaaattgaaggatgggctgggtcttgatccatctcgaagtcgccggagcc  
ttgtatccgaacgaggttatatcggattttgcattcttaccttttgggtggcggaaccacgaaaatgtgttgg  
ggaccaatttgcctctgatggagtccactgtagcgttgactatgctgctccagaattttgacgtggaactaa  
aagggaacctgaatcgggtggaactagttactggggcaactattcataccaaaaatggaatgtggtgcaga  
ttgaagaagagatctaatttacgttga

**Figure 30**

SEQ ID NO: 56: novel cytochrome P450 monooxygenase diatom CYP97B

*Skeletonema costatum*:

MASYESDLLSTWDEDPSLQKGFDEIEKLRRYFAGLRQTPDGRWVRKSTLFEFLVTNSPSKVVGVPDGER  
YESPPKPVNIFDVGVLVGKNTLTWLGFGPNLGMAAVPDAVIQYEGSFFTFIK GALGGDLQTLAGGPLFLL  
LAKYYTDHGPIFNLSFGPKSFLVISDPVMARHILRDSSPEQYCKGMLAEILEPIMGDGLIPADPKIWKVRR  
RAVVPGFHKKWLNNSMIGLFGDCGDRLVDDLEKRSTSDKPVIDMEERFCSVTLDIIGKAVFNYDFGSVTKE  
PIVKAVYRVLREAHRSSSFIPYWNLPYAEKWMVGQVEFRKDMGMLDDILAKLINRAVETRQEATVEELEE  
RETSDDPSLLRFLVDMRGEDLTSKVLRDDLMTMLIAGHETTAAMLWTMFGLVSNDPGMMKEIQAEVRTVM  
GNKSRPDYDDVVAMKKLRYALIEALRLYPEPPVLIRRARQEDTLPPGGTGLSGGVKVLRGTDIFISTWNLH  
RAPEYWENADKYDPTRWERPFKNPGVKGWNGYDPEKQSSQSLYPNEITSDYAFLPFGAGKRKCIGDQFAML  
EASVTLSMIMNKFDFTLVGTPEDVGMKTGATIHTMNGLNMMVSPRSETNPIPGTNEWWTQHLMRGLSSTG  
RPYTSDEDAAWTTSANGMRP



**Figure 31**

SEQ ID NO: 57: novel cytochrome P450 monooxygenase diatom CYP97B

*Skeletonema costatum*:

atggcctcctacgagagtgatctgctctcaacatgggatgaagatccatcgctgcaaaaggggtttgactg  
ggagattgaaaagctccgtcgggtactttgccggactgcgtcaaacaccagacgggcgatgggtgcgcaagt  
cgacactgtttgagtttcttgtagacaaactctccaagtaaagtagttgggtaggtccggatggggaacgg  
tatgaaagccctccgaaaccagtcaatatcttcgatgtgggagtgttagtcggtagaatacactcacttg  
gttgggatttggaccgaatttgggtatggcgcgggtacccgatgcagtcattcaaaagtatgagggtagct  
tcttcacctttatcaagggagcattgggggggtgatttgcaaactttggcgggtgggtcctttgttcttattg  
cttgccaagtattatacggatcatggaccattttcaacttgagttttggaccaaaagagctttttgggtgat  
ttcggatcctgttatggcgaggcatattttgagggatagttcaccggagcagtagttgtaaggaatgcttg  
cggagattttggaaccgatcatgggtgatggattgattcctgcagatccaaagatttggaaggttcgtcga  
agagctgtcgtacctgggtttccacaaaaagtggtgaacagcatgattgggtttgttcggagactgtggtga  
tcgtctcgttgacgatctagaaaagcgttctacttcagataaacctgtaattgacatggaagaacgattct  
gttcgctcacactcgatatcatcggtgaaggcagtagttcaactatgattttggatcagtgacaaaggaatca  
cctattgtaaaggcagtagatacagagtgttacgtgaggcggagcacagatcatcttcgttcacccctactg  
gaacttgcttatgctgagaaatggatggtaggacaggttgaattccgcaaagatatgggaatgcttgacg  
atatcttggcaaaactgatcaatcgtgctgttgagactaggcaagaagctactgtcgaagagttggaagag  
agagaaacaagcgatgatccgagtcctttaagggttcctagttagatagaggggagaagatttaacgagtaa  
agtgttgagagatgatttgatgacaatgcttattgcaggacatgaaacaacagcggcaatgctgacgtgga  
caatgtttgggctagtaagcaacgatcctggcatgatgaaggaaatccaggcagaagttcgaactgtcatg  
ggcaataagtctcgaccagattacgatgatgttggtggcgatgaaaaagttgaggtatgctttgattgaagc  
acttcgattatatcccgagccaccggtgttgattcgcagggcaaggcaagaggacactcttccaccaggtg  
gtacgggtctttctggaggtgtcaaagtattgcgtggaacagatatctttatttctacttggaaaccttcac  
cgcgctccagaatactgggagaatgcagacaaatatgacctactcgatgggagcgtccgttcaaaaaacc  
aggtgttaagggttggaaatggatatgatccggaaaaacaatcatctcaatcactttatcctaacgagataa  
cgtcagactatgctttccttcttttgggtgctgggaagagaaaaatgtatcggggatcagtttgctatgctc  
gaggcttcggttacactatcgatgattatgaataaatttgacttcacgttggtcgggtacccctgaagatgt  
cggcatgaagaccggagcaactattcataccatgaatgggctcaacatgatggtcagccctcgatcagaga  
caaaccgattccagggaacaaatgagtggtggacgaaacaacatctaagagaggtttgagttctactgga  
agaccatacacttccgatgaagatgcccgtggacgacatccgctaattggcatgagaccgtga

**Fig. 32**

SEQ ID NO: 58: single knockout mutant CYP97A3 *Arabidopsis thaliana*  
(SALK\_116660):

